Milligan College Library
3 1881 0003 3966 9

The Contemporary American Organ

By

WILLIAM H. BARNES

Milligan College Library
ML561.B2 MM
The contemporary American organ :its evo
3 1881 0003 3966 9

Nov. /30 —

Digitized by the Internet Archive
in 2022 with funding from
Kahle/Austin Foundation

https://archive.org/details/contemporaryamer0000unse_s8i3

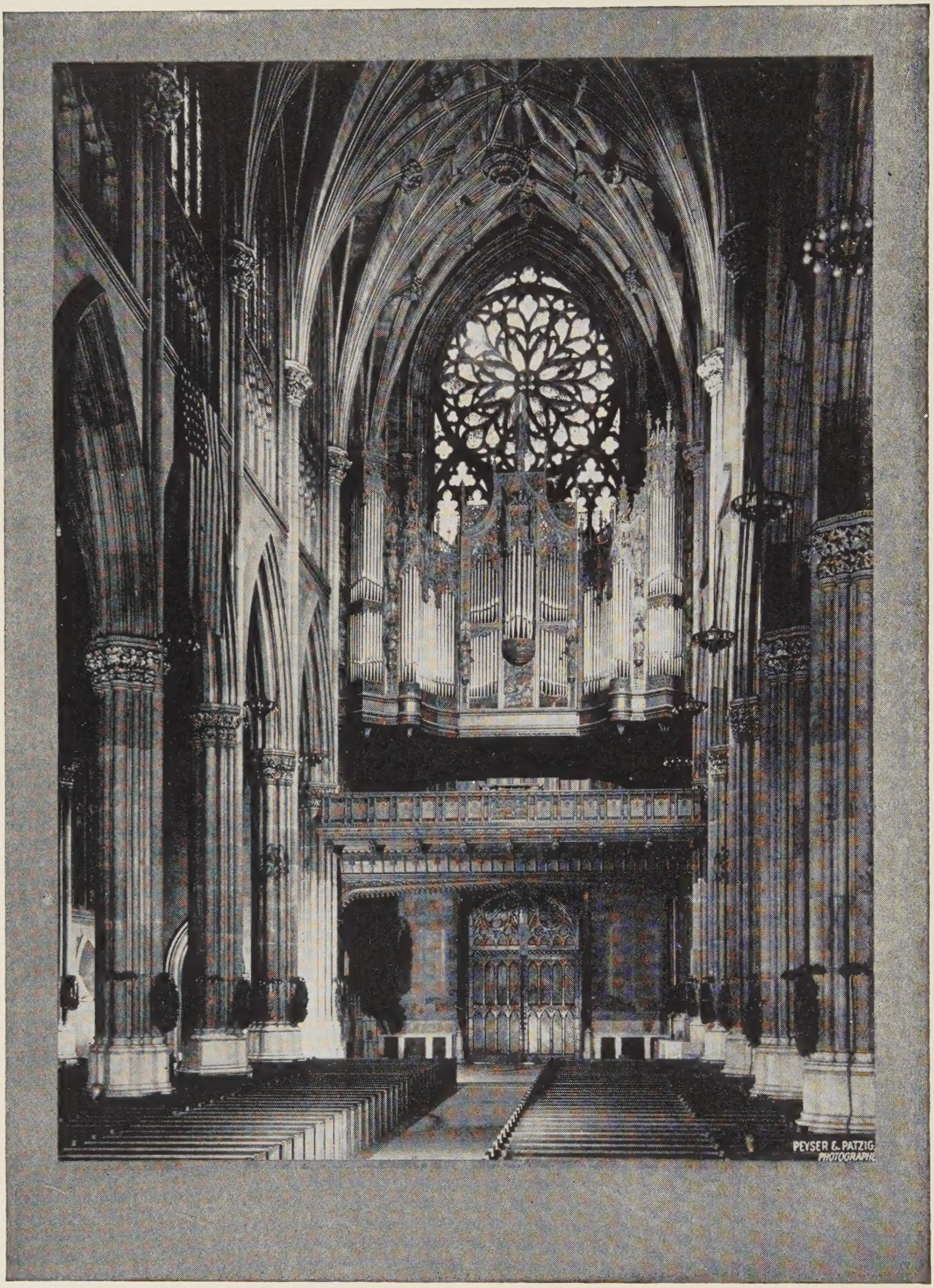


Plate I.—(Frontispiece)

St. Patrick's Cathedral, New York City. This is considered one of the most beautiful organ cases in America, and was designed by Robert J. Reilly. All of the organs in the Cathedral were built by Geo. Kilgen & Sons, St. Louis.

The

Contemporary American Organ

Its Evolution, Design and Construction

by

WILLIAM HARRISON BARNES

Organ Architect
A. B., Harvard University
Associate Editor, The American Organist
Organist, First Baptist Church, Evanston, Illinois

Profusely Illustrated

J. FISCHER & BRO.
119 W. 40th St., New York
1930

P. H. WELSHIMER MEMORIAL LIBRARY
MILLIGAN COLLEGE, TENN. 37682

ML
561
.B2

L.C. 30-31722

Copyright 1930 by William H. Barnes

British Copyright secured
All rights reserved, including that of
Translation into Foreign Languages

Printed in U.S.A.

Printed by
RICHMOND BOROUGH PUBLISHING & PRINTING CO.
Port Richmond, N. Y.

To my wife,
EDITH MCMILLAN BARNES:

In grateful recogniton of her encouragement and assistance.

"If this work finds favor, hers the honor; if it fails, mine the blame."

52260

TABLE OF CONTENTS

PAGE
Introduction 7
Chapter 1—A Brief History of the Organ 11
Chapter 2—The Wind Supply of the Organ 18
  a—Development of the Bellows and Blowing Mechanism 18
  b—Measuring of Wind Pressure 23
Chapter 3—The Sound Producing Portions of the Organ........ 30
  a—Construction of Metal Flue Pipes........ 30
  b—Construction of Wood Flue Pipes........ 41
  c—Construction of Reed Pipes........ 56
  d—Construction of Diaphones 69
  e—Pipes of Extraordinary Power on High Pressure Wind 73
Chapter 4—Pipe Scales 81
Chapter 5—Harmonic Corroborating Stops 86
Chapter 6—Voicing of Organ Pipes 95
Chapter 7—Tuning of Organ Pipes 104
Chapter 8—Means of Obtaining Expression 111
Chapter 9—The Tremulant 126
Chapter 10—Percussion Tone in the Organ 133
Chapter 11—General Remarks on the Tonal Design of the Organ. 139
Chapter 12—Specific Examples of Good Tonal Design 152
Chapter 13—Transference of Stops—Unification 186
Chapter 14—The Location and Space Requirements of the Organ. 196
Chapter 15—A History of the Organ Action 208
Chapter 16—A History of the Organ Console 219
Chapter 17—A General Description of the Electro-Pneumatic Action 236
Chapter 18—Types of Modern Windchests 250
  a—The Universal "Airchest" 250
  b—Windchests with Ventil Stop Action and Individual Pipe Valve Pneumatics 260
  c—Windchests with Some Form of the Pitman Stop Action 270
  d—The Ventil Windchest without Individual Pipe Valve Pneumatics 284
  e—The Direct Electric Action 287
Chapter 19—Specific Examples of Modern Console Action 293
  a—Key Contacts and Coupler Action 293
  b—Combination Action 296
  c—Relay Action 299
Chapter 20—The Automatic Player as Applied to the Organ 308
Chapter 21—Suggestions to Prospective Purchasers of Organs 323
Concluding Remarks 333

LIST OF ILLUSTRATIONS

EXAMPLES OF ARTISTIC ORGAN CASES

PAGE
Plate I St. Patrick's Cathedral, New York....... Frontispiece
Plate II Cathedral of St. John the Divine, New York 10
Plate III Chapel of the Intercession, New York 17
Plate IV St. James the Less, Philadelphia 29
Plate V Emmanuel Church, Boston 80
Plate VI Mormon Tabernacle, Salt Lake City 85
Plate VII Trinity Lutheran Church, Lancaster 94
Plate VIII Liverpool Cathedral, England 103

EXAMPLES OF LARGE ORGAN CONSOLES

Plate IX St. Gervais, Paris 110
Plate X Pierre S. duPont Residence 125
Plate XI Auditorium, Washington, D. C. 138
Plate XII Auditorium, Cleveland 151
Plate XIII St. George's Church, New York 155
Plate XIV St. Patrick's Cathedral, New York 159
Plate XV Royal York Hotel, Toronto 163
Plate XVI Ball Room of the Auditorium, Atlantic City 168
Plate XVII High School, Atlantic City 172
Plate XVIII Liverpool Cathedral, England 175
Plate XIX St. Michael's Church, Hamburg 180
Plate XX Wanamaker's Store, Philadelphia 183

INTERIORS OF ORGANS AND ORGAN FACTORIES

Plate XXI Pierre S. duPont Organ in the Aeolian Factory... 185
Plate XXII Auditorium Organ, Atlantic City, Echo Division .. 189
Plate XXIII Auditorium Organ, Atlantic City, Echo Division .. 195
Plate XXIV Sesquicentennial Exposition Organ, Philadelphia . 199
Plate XXV Erecting Room, Geo. Kilgen & Son's Factory 204
Plate XXVI Windchest Room, Welte-Tripp Factory 204
Plate XXVII Windchest Room, M. P. Moller Factory 207
Plate XXVIII Small Two Manual Organ, M. P. Moller Factory.. 228
Plate XXIX Ball Room of the Auditorium, Atlantic City 232
Plate XXX Action and Voicing Rooms, Hook and Hastings.. 332

ILLUSTRATIONS OF THE VARIOUS PORTIONS OF AN ORGAN

(Historical and Descriptive)

PAGE

Figure 1 Ancient Hydraulic Organ 12

Figure 2 Cross Section of Bellows 19

Figure 3 Bellows Operated by Water Motor 20

Figure 4 Three Feeder Bellows 21

Figure 5 Three Valve High Pressure Reservoir 22

Figure 6 The "Orgoblo," a Successful Fan Blower 25

Figure 7 Phantom View of an "Orgoblo" 25

Figure 8 Phantom View of the "Kinetic" Fan Blower 27

Figure 9 Sectional Views of Metal and Wood Pipes 33

Figure 10 Application of Harmonic Bridge to Pipes 33

Figure 11 Three Treatments of the Languid in Diapason Pipes . 33

Figure 12 Construction of Metal Pipes 34

Figure 13 Various Examples of Metal Pipes 36

Figure 14 Examples of Haskell's Short Length Pipes 38

Figure 15 Large Size Metal Pipes 40

Figure 16 Large Size Wood Pipes 42

Figure 17 Parts of Pedal Bourdon 42

Figure 18 Construction of Wood Pipes 43

Figure 19 The Pedal Diapason and Clarabella 45

Figure 20 The Hohl Flute and Bourdon 47

Figure 21 The Pedal Violone 49

Figure 22 The Doppel Flöte and Gedeckt 51

Figure 23 The Polyphoned Bourdon-Gedeckt 53

Figure 24 Portions of Reed Pipes 60

Figure 25 Construction of Reed Pipes 62

Figure 26 Various Examples of Reed Pipes 64

Figure 27 Examples of Various Types of Pipes 67

Figure 28 The Diaphone 70

ILLUSTRATIONS OF THE VARIOUS PORTIONS OF AN ORGAN—(CONT.)

PAGE

Figure 29 Sectional Views of Double Languid Pipes 75

Figure 30 Method of Drawing a Pipe Scale 82

Figure 30-a The John Compton Pedal Cube 102

Figure 31 The "Sound-Trap" Joint 115

Figure 32 Individual Shutter Pneumatics, (M. P. Moller) 116

Figure 33 The Whiffle-tree Shutter Motor, (Skinner) 117

Figure 34 Individual Shutter Pneumatic, (Kimball) 118

Figure 35 Special Shutter Construction (Austin) 120

Figure 36 Expression Pedal Construction (Austin) 122

Figure 37 Expression Pedal Construction (Moller) 122

Figure 38 The Valve Tremulant 130

Figure 39 The Bellows Tremulant (Kimball) 130

Figure 40 The Vibra-Harp (Deagan) 132

Figure 41 Detail View of the Vibra-Harp (Deagan) 134

Figure 42 Organ Percussions and "Traps" 136

Figure 43 The "Augmented Pedal" 191

Figure 44 Wiring Diagram for Unit Stops 193

Figure 45 Space Requirements of an Organ 201

Figure 45-a Hall Organ Company Console (Rear View) 206

Figure 46 Side View of the Pallet and Slider Windchest 209

Figure 47 Front View of the Pallet and Slider Windchest 209

Figure 48 The Tracker Action 211

Figure 49 The Barker Lever 215

Figure 50 The Tubular Pneumatic Action 216

Figure 51 Tubular Pneumatic Stop Action 217

Figure 52 The Pedal Couplers, Tracker Action 219

Figure 53 The Manual Couplers, Tracker Action 221

Figure 54 The Pneumatic Couplers 224

Figure 55 The Early Electro-Pneumatic Action 238

ILLUSTRATIONS OF THE VARIOUS PORTIONS OF AN ORGAN—(CONT.)

PAGE
Figure 56 The Hope-Jones Magnet 239
Figure 57 Sectional Views of Two Magnets 241
Figure 58 Winding Magnets (Kilgen) 243
Figure 59 Parts of the Moller Magnet 243
Figure 60 The Austin Air Chest 251
Figure 61 Enlarged View of an Austin Pneumatic 253
Figure 62 The Austin Action Power Unit 255
Figure 63 Details of the Austin Magnet 257
Figure 64 The Roosevelt Windchest 259
Figure 65 The Roosevelt Pneumatic 261
Figure 66 The Estey Windchest (Front View) 262
Figure 67 The Estey Windchest (Side View) 264
Figure 68 The Estey Tubular Pneumatic Windchest 265
Figure 69 The Channel Boards of a Windchest 266
Figure 70 The Kilgen Straight Windchest Action 267
Figure 71 The Kilgen Unit Windchest Action 268
Figure 72 The Kilgen Pedal Windchest Action 269
Figure 73 A Photograph of Section of the Pitman Windchest .. 271
Figure 74 The Skinner Pitman Windchest 272
Figure 75 The Primary Mechanism (Kimball) 274
Figure 76 Sectional View of the Kimball Windchest 276
Figure 77 A Three Stop Kimball Windchest 277
Figure 78 The Moller Windchest 280
Figure 79 The Moller Windchest with Inside Primary 281
Figure 80 A Photograph of the Bottom of a Moller Windchest .. 282
Figure 81 The Pilcher Windchest 283
Figure 82 The Hillgreen, Lane & Co. Windchest 285
Figure 83 The Wicks Direct Electric Action 287
Figure 84 An Early Casavant Windchest Primary 288

ILLUSTRATIONS OF THE VARIOUS PORTIONS OF AN ORGAN—(CONT.)

PAGE
Figure 85 Casavant Key Contacts 288
Figure 86 An Early Casavant Console 290
Figure 87 Early Combination and Coupler Action (Casavant) .. 292
Figure 88 Ottawa Cathedral Console (Casavant) 294
Figure 89 The Kimball Key Contacts (Multiple) 295
Figure 90 Photograph of the Standard Kimball Key Action ... 295
Figure 91 The Austin Key Action 297
Figure 92 The Austin Coupler Rollers 298
Figure 93 The Moller Key Action 300
Figure 94 The Kilgen Key Action 301
Figure 95 The Hillgreen, Lane & Co. Key Action 303
Figure 96 A Two Manual Estey Console (Section) 304
Figure 97 The Original Austin Combination Action 306
Figure 98 Early Form of Austin Combination Action 307
Figure 99 Present Form of Austin Combination Action 309
Figure 100 The Hillgreen, Lane & Co. Combination Action...... 310
Figure 101 The Pilcher Combination Action 312
Figure 102 Rear View of Small Moller Console 313
Figure 103 A Closer View of the Same Console 315
Figure 104 The Moller Combination Action 316
Figure 105 The Kilgen Combination Action 318
Figure 106 The Kimball Remote Control Action 319
Figure 107 The Hillgreen, Lane & Co. Relay Action 321
Figure 108 The Kilgen Relay Action 321
Figure 109 The Kimball Electro-Pneumatic Relay 322
Figure 110 One Form of Contact Box and Relay (Moller) 324
Figure 111 The Reversible Pedal Mechanism 325
Figure 112 The Crescendo Pedal Mechanism 327
Figure 113 The Austin Console (Case Removed) 328
Figure 114 "Waiting for the Verdict" 335

INTRODUCTION

THE chief purpose of this work is to acquaint the reader with the details of present day organ building, as practiced by the leading builders of America, particularly with regard to the mechanisms employed.

The author does not know of any work of this kind that has been available heretofore. As an introduction to those chapters which deal in detail with mechanical matters connected with present day American organ building, it was thought advisable for the sake of completeness, to add several chapters of an historical nature. The author is well aware that tonal matters connected with organ building have been covered completely in several great works, e.g., Dr. G. A. Audsley's "Art of Organ Building" and Hopkins & Rimbault, "The Organ," and many lesser ones. He is equally aware that the history of the organ has been written by many authors of greater attainments and sources of knowledge than he has at his disposal. In those chapters relating to historical and tonal matters there is little, if any, occasion for claiming much originality. The reasons for giving brief consideration to these matters in a work of this kind are for the sake of completeness and also for a better understanding of the evolution of those actions which will be described. The reader would inevitably feel "in the dark" were present day organ actions described without a short prelude of what had been done mechanically heretofore.

Those readers who are familiar with the history of organ building, and such subjects as the construction of organ pipes, may skip these sections of the work and perhaps discover material of originality and interest in those chapters devoted to specific descriptions of organ actions, (both console and windchest) which our leading builders are employing today.

As Associate Editor of the "American Organist," the author has frequent inquiries from earnest students, for a book that would enable them to gain some practical knowledge of the modern electro-pneumatic organ. Audsley's great work, "The Art of Organ Building" contained all the information that such a student could desire up to the time it was written. That was about twenty-five years ago and unfortunately this work is now out of print, very difficult to obtain and only at prohibitive prices. Dr. Audsley's later works give no consideration to mechanical matters. About eighteen years ago there was a very useful book printed by George L. Miller called "The Recent Revolution in Organ Building", which contained valuable information concerning modern work up to that time. This book is also no longer available, and has the further disadvantage of being extremely prejudiced in favor of one builder. In view of these facts, some useful purpose may be served by making available in one volume both old and new information.

This book is written, first, for the beginner and student of the organ to whom all matters relating to the modern organ are more or less of a mystery, and second, for organ builders and advanced students of organ construction who are interested in knowing precisely the type of action and mechanical system which their contemporaries are using.

It has been a source of great satisfaction to have received the heartiest co-operation of numerous organ builders in the preparation of this work. The very fact that such co-operation has been received so freely, indicates that there has been a remarkable change in attitude of organ builders toward each other. It is gratifying to know that the day in which each builder was suspicious of his contemporary and afraid that the others might learn his secrets of construction seems to have passed in America. Certainly only good can come when a wider dissemination of knowledge of what is being done is available to all.

Though the modern organ is a highly ingenious and complicated mechanism, (the product of numerous inventive minds over a period of many centuries) yet there should be no mystery about it. Even in its present high state of development, every mechanical part of it, although more difficult to explain than the earlier types of organ action, is susceptible of explanation.

Certain subjects are discussed herein, particularly with regard to the tonal design of the organ and the somewhat related subject of unification which are highly controversial at the present time. The author has thought it wise to quote from a recognized English authority, Mr. Donald Harrison, and the well-known American, Mr. Emerson L. Richards, as well as to give his own views and those of others competent to speak. Strong statements of opinion have been avoided as far as possible. The writer desires that this book shall not, however, be merely a colorless recording of present day organ building practices in America; yet hopes to have made an impartial presentation. If partiality has been shown, it is unintentional and the author must ask the reader's indulgence.

This book by no means aims to give specific drawings and information about the work of every American organ builder. That would manifestly take more space than is at his disposal, and would be quite unprofitable from the standpoint of information. The work of many of the important builders is given in some detail. All general types of action usually employed by American organ builders are shown, also some highly specialized and unique types, where the builder has done enough important work to justify such consideration, or if the builder's work is alone in its class, such as direct electric action. The writer has necessarily reserved the privilege of including the information that in his judgment will best satisfy the two classes of readers referred to.

Acknowledgements and heartiest thanks are due to all builders who have so kindly permitted the writer the use of their shop drawings from which the reproductions in this book are made. The origin of each drawing is credited in the text, by mention of the name of the builder. If original drawings had been required for the many actions illustrated, the task would have been considered too formidable to have been attempted.

The drawings which are used in connection with the description of older actions, and some of the drawings of organ pipes have been reproduced from various works on the organ, acknowledgement being accorded in each case.

The writer is indebted to Mr. T. Scott Buhrman, Editor of the "American Organist", for permission to use many half-tones of organ cases and consoles that have previously appeared in that journal. Mr. Buhrman has been of great assistance in reading both the copy and proofs of this work. He has also granted permission to quote from many of the author's articles in the "American Organist", and from other articles in that magazine.

Acknowledgements and thanks are due to that great authority on organ tonal matters, the Rev. Noel Bonavia-Hunt for his kind permission to quote freely from his work, the "Church Organ." Finally, to all others who have either given permission to quote, or in other ways have assisted in the preparation of this work, the author wishes to convey his thanks.

Chicago, July 29, 1930

Plate II.

Cathedral of St. John the Divine, New York City. Skinner Organ Company, builders of the organ.

CHAPTER I.

A BRIEF HISTORY *of the* ORGAN

THE origin of the organ dates back to great antiquity. The flute, which is a component part of the organ, is one of the most ancient of musical instruments. It is pictured on the walls of early Egyptian tombs; specimens of it still in playable condition have been unearthed and can be seen in our museums. The Pipes of Pan are sometimes considered to be the original source of the organ. Frequent allusion is made to the organ in the Bible, though it is not at all clear that this refers to even the ancient type of organ. The ancient Greeks had no particular musical instrument called an organ, but the word with them was a general name for an instrument, work, or an implement of any kind. Confusion may have arisen concerning this term by the translators of the Bible from the Greek. The Greek musical theorists applied the word "organic," as a general term, to instrumental music.

About 284-246, B.C. a man named Ctesibius, who followed his father's trade of barber, being of a mechanical turn of mind, noticed that the counter-weight of a movable mirror used for the purposes of his trade, produced a musical sound by the force with which it drove the air out of the tube in which it moved. By experimenting he succeeded in making a machine containing only a single vase, inverted, with an opening at the top to which was attached a trumpet. When water was pumped into the base of the vase, the air was driven forcibly through the trumpet, producing a very powerful sound. This machine caused so much admiration it was consecrated to the temple of Venus.

The principle involved may be illustrated by the modern fire engine, which is practically the Ctesibian vase reversed. In the ancient instruments, water was used to force air in a steady flow through an opening in the top of a hemisphere. In the modern fire engine, air confined in the top of a hemisphere forces the water in a steady stream through an opening in the bottom.

A pupil of Ctesibius, named Hero, an engineer, wrote a work called "De Pneumaticis," in which he described many mechanical applications of steam, water and air. He also gave a description of a musical instrument developed from the old Ctesibius trumpet in which the air was conveyed from the vase to a row of pipes arranged in the order of a musical scale, any one of which could be caused to sound at will, the motive power being supplied by water. The instrument was called the "Hydraulus" and appears to have been a predecessor of our organ, more directly than the ancient flute.

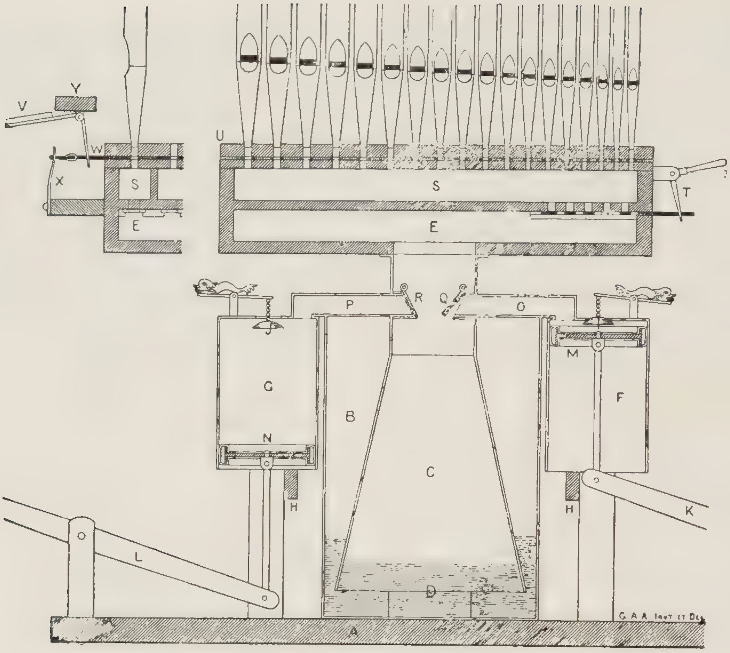


Figure 1.

Ancient Hydraulic Organ. Invented by Ctesibius about 200 B.C. Drawn by G. A. Audsley from photograph of terra cotta models by Rev. Père Delatre. Models found at Carthage. When the piston N, was forced up in the cylinder, G, air was directed though P into the inverted vase, C. The pressure of air in this vase against the water, D, drives the water up on either side into B. When the cylinders are not supplying air, the valves R Q close, preventing the escape of air. The weight of the displaced water forces the air in a more or less steady stream into the pipes. The water in the early organ took the place of a reservoir for producing more even pressure on the wind. The two cylinders, with their pistons were later supplanted by feeders.

The Hydraulus became exceedingly popular, and was for centuries a source of admiration and astonishment to the unlearned. "The powerful sound, the mysterious pumping of the water, the exertions of the slaves who were obliged to pump with all their might to supply air of sufficient quantity, all combined to attract attention to it." This instrument was used for contests, public games, feasts, and even in homes of the wealthy.

In the British Museum are ancient Roman coins of the time of Nero that depict the Hydraulus quite clearly. A piece of pottery recently found at Carthage represents a performer seated between the two cylinders described by Vitruvius. The Emperor Nero was particularly attracted by the Hydraulus.

Tertullian, speaking of Ctesibius as the inventor and Archimedes as the improver of the Hydraulus, says: "Observe the extraordinary genius of Archimedes. I speak of the Hydraulus. What members, what parts, what joinings, what rows of pipes, what a compendium of tibiae, and all composing one great whole! That spirit, which breathes from the trouble of the waters, is administered through the parts, is solid in substance, divided in operation."

The compass of the Hydraulus must have embraced about three octaves at about 100 A.D. The pipes were tuned to the ancient Greek modes. The use of water in the Hydraulus was to steady the pressure of wind. An organ pipe will rise in pitch if the pressure is slightly increased. It has been the object of organ builders in all ages to supply wind to the pipes at an even pressure. Immense difficulties have had to be overcome to finally accomplish this. When water was no longer employed to steady the wind, organs built with regular bellows were called by ancient historians, "pneumatic" organs to distinguish them from the Hydraulus. In the Hydraulus the pipes were made to sound by opening valves admitting air, played by keys, somewhat like the modern organ.

St. Augustine applied the word "organum" to any musical instrument, but particularly to any which was blown by bellows, in which connection he used the word in the plural. The Talmud mentions an organ of ten pipes played by a key-board as being in existence in the second century.

About the year 951 modern harmony took its rise. Before this, so far as any one knows, there had been no harmony beyond a drone bass, and the vast companies of musicians described in the Bible and elsewhere must have played and sung in unison.

Sir John Stainer says, "The large pipes of every key of the old organ stood in the front. The whole instrument sounded and shrieked in a harsh, loud manner. The key-board had eleven to thirteen keys in diatonic succession without semitones. It was impossible to get anything except a choral melody for one voice on such an organ. The width of a single key amounted to three inches and even as much as five to six inches. The valves to the keys and the whole mechanism being clumsy, playing with the finger was not to be thought of, but the organist was obliged to strike with the clenched fist and the organist was often called an 'organ beater'."

Gradually the keys were reduced in size and semi-tones were added. Before the year 1500 the keys had approximately reached their present normal proportions. The invention of the pedal key-board is credited to the German, Bernhard, a skillful musician of Venice, about the year 1470.

Hopkins & Rimbault think that it was certainly earlier than this. A study of the organ compositions of Frescobaldi, the celebrated Italian organist, who lived in the early part of the seventeenth century, indicates that the organ was then playable by fingers and pedal keys, as at present.

From about the beginning of the sixteenth century until the early part of the nineteenth there does not appear to have been any great improvements made in organ building, except a gradual improvement of the pipe work.

The organ was from very early time used in connection with the music of the Church, though in the thirteenth century the Priests of both the Greek and Roman church thought the use of organs in divine service to be "scandalous and profane." Even to this day the Greek church does not tolerate the use of organs in its services. In spite of this, largely due to the fact that education of any sort was generally confined to monasteries and castles, the use of the organ and other musical instruments became general not only in great churches, but in monasteries and convents. The historians of this period make much of several monks distinguished for their art of playing the organ and other musical abilities.

The *Regal* was a portable organ, having one row of pipes sounding the treble notes, that was used in processions, carried by one person and played upon by another. In contrast to the Regal or portable organ, there was the *Positive* organ from the Latin word *ponere,* "to set down." This instrument was provided with a key-board of full compass and was played upon with both hands. The portable organ was used principally to assist the voice and to play the melody of the plain song.

Sir John Hawkins states, "The Positive is the noble instrument to the harmony whereof the choral service has, ever since its inception, been sung. The Regal, or portative, on account of its smallness and the simplicity of its construction, was so-called."

Hopkins & Rimbault, in their history of the organ, explain the term which is frequently found in medieval manuscripts concerning organs in which an organ is nearly always referred to as a "pair of organs." They state, "The truth is that a pair of organs meant simply an organ with more pipes than one, similar to the way we frequently refer to a flight of stairs, as a pair of stairs."

Numerous examples of old organs, of various types and some very beautifully finished are to be seen at the Metropolitan Museum of Art in New York and also at the George F. Harding Museum in Chicago.

A large organ existed in the Winchester Cathedral, England, in the tenth century, which caused widespread attention and comment from the medieval writers.

Nearly all early organ builders were ecclesiastics, usually monks of a mechanical turn of mind. It was not until about the fifteenth century that organ building became a profession. For many centuries it appears that organ building was developing in various parts of Europe, but more especially in Germany, France and England. These latter countries possessed distinct schools of organ building until nearly the beginning of the nineteenth century.

Perhaps the most important school of organ building from about 1359 until 1780 was the German—Saxony in particular. Over two hundred organ builders can be counted in Saxony alone as having flourished during this period, including such masters as the Silbermanns, Hildebrand, Gubler, Sommer and Herbst. The great Bach played upon organs of Silbermann.

Since the time of Luther, the German worshippers have been devotional and almost always possessed of strong musical voices. To support this hearty and enthusiastic congregational singing, organs of considerable magnitude were required. To build large organs, until after the invention of the pneumatic lever, was beset with great difficulties. The touch or resistance of the keys became so heavy that it put a practical limit to the size of the organ.

The only measures then known to combat this unsatisfactory state of things were:

1. To retain a moderate wind pressure, but to make the windchest pallets small, only capable of supplying a few stops at one time. This allowed every stop to be used individually and a fair number together, but virtually reduced a large organ to a small one. For example, an organ of forty stops was furnished with pallets only sufficiently large to permit the use of half this number at any one time. These could be chosen in successive groups according to the taste of the organist, but it was impossible to play "full" organ.

2. To reduce the wind pressure somewhat, thereby largely spoiling the effectiveness of the reed stops and the upper portions of the flue work. The French school usually chose the former method, while the German school of builders employed the latter.

Dom Bedos, in his great work (written 1766-1768) "L'Art de Facteur d'Orgues," has a long chapter on what he considers "usual and desirable" stop combinations. He says, for example, "No Flue Work is ever to be used with the pedal reeds." Some of the combinations he suggested seem weird to a modern organist, but they were necessary because of the fact that the whole or "full" organ could not be used at the same moment.

The organ in France had seldom to sustain large masses of congregational singing, so that it came to be treated merely as a kind of orchestra, intended to embellish the services of the Roman Catholic Church. It was customary, and still is, in the large churches of France, to have two organs, a small one in the chancel to accompany the choir, and a much larger organ in the gallery at the west end of the church, whereby brilliant technical displays are possible at intervals during the service.

The German system of employing low wind pressures was unfavorable to good reed tone, so this latter was largely neglected. They invented as a substitute, that lovely family of organ tone, known under the general name of "Gamba."

The English school was greatly influenced by the German, as several important German builders did much work in England, e.g., Father Smith, Schulze, and Snetzler. The influence of these men was very great on English organ building. As the English did not require such large organs, they ordinarily employed slightly higher pressures and made many improvements of their own.

Later pages will mention more specifically the inventions of three Englishmen that greatly improved the organ. They were as follows:

Jordan's Swell, rendering the organ capable of expression;

The invention by Flight of inverted ribs in the bellows reservoir, affording much steadier wind pressure;

Barker's pneumatic lever, permitting organs to be built of any size, and still be capable of being played "full" organ, as the resistance to opening large pallets was overcome pneumatically.

These various discoveries and inventions enabled the modern builder to develop these ideas and to combine effects hitherto only attained in different countries under conditions special to each.

The two greatest organ builders of 19th century England and France, "Father" Willis and Aristide Cavaille-Coll will be more specifically mentioned in our chapters on the Construction of Organ Pipes, and the Development of the Pneumatic Action. Even though the organ has such great antiquity and a more or less constant evolution, it is perhaps not too much to say that there have been as many improvements made in it both tonally and mechanically in the past thirty to fifty years as in the many centuries previous. These later improvements we shall examine in some detail in the following pages.

From the foregoing brief account of the early history and development of the organ, it appears evident that the organ is in truth one of the most ancient of musical instruments and has had continuous evolution bringing it to its present state of high musical efficiency.

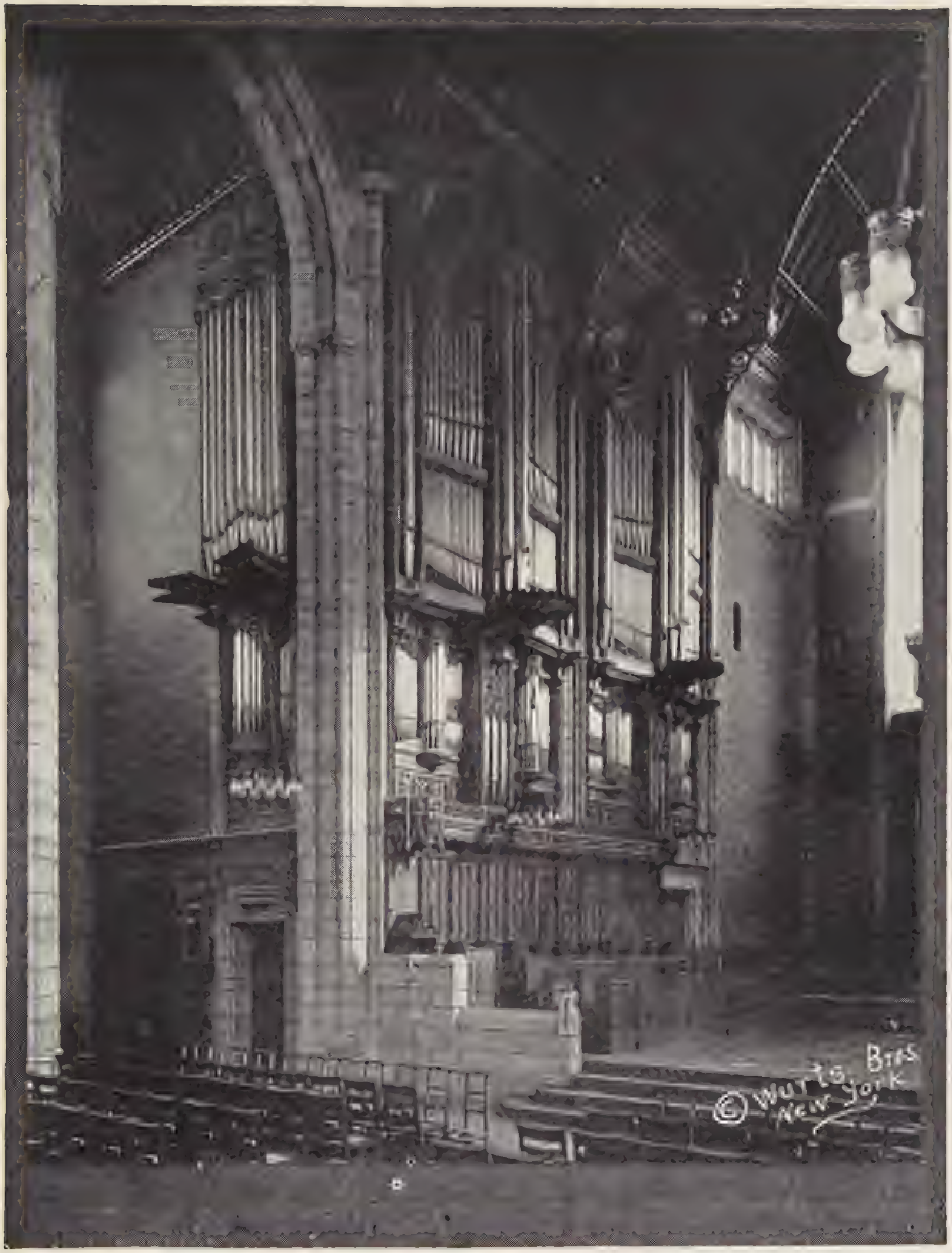


Plate III.

Chapel of the Intercession, New York City. Austin Organ Company, builders of the organ. The casework was designed by Bertram Grosvenor Goodhue.

CHAPTER 2.

THE WIND SUPPLY *of the* ORGAN

THE organ is, as everyone knows, primarily a wind instrument. It is of the greatest importance that it be supplied with an adequate amount of wind at a steady pressure, which is determined at the time the pipes are originally voiced.

The earliest devices for supplying wind to the organ were crude affairs. They resembled the bellows formerly to be seen in every blacksmith's shop. These have been superseded of late years by a rotary blower, known as a forge blower, as is the case with the organ bellows.

In order to overcome the violent unsteadiness of wind inevitable when an organ was supplied directly from a bellows of this type, a reservoir was added above the simple wind collecting apparatus, into which the compressed air or wind was fed from the feeders. Figure 2 shows such a reservoir with the feeders below.

The reservoir itself consisted of a double set of folds or ribs, the upper set folding towards the outside of the reservoir, and the lower set folding inside. Air is admitted into the feeders by a series of holes cut in the bottom boards, covered with a set of valves on top. The bottom of the reservoir has another set of holes covered also by valves, both sets of valves opening upwards. In its normal position one of the feeders hangs down, so that it can be opened to its fullest extent and filled with air. On raising this feeder, the valves in the bottom board are driven shut and the air within it is driven into the reservoir. On allowing the feeder again to descend, the valves in the reservoir close and prevent the return of the air, while at the same time the valves of the feeder open and admit the air which is driven into the reservoir at the next upstroke of the feeders. A safety valve is provided at the top of the reservoir, which will allow air to escape in case the reservoir is raised beyond a certain point, thus preventing any danger of its bursting. It was considered that the two sets of folds or ribs of the reservoir closing in opposite directions caused the pressure to remain steady, no matter whether the reservoir was widely open or nearly closed. If there was only one set of ribs, it was found the pressure would be constantly varying. As a matter of fact, the pressure was constantly varying anyway with this type of reservoir fed by feeders, as everyone knows who is familiar with the hand-pumped or water-motor driven organ of many years ago. No doubt the double system of folds was a valuable improvement. This is the type of bellows which supplied wind to most of the organs in the United States up to within recent years. In fact, some

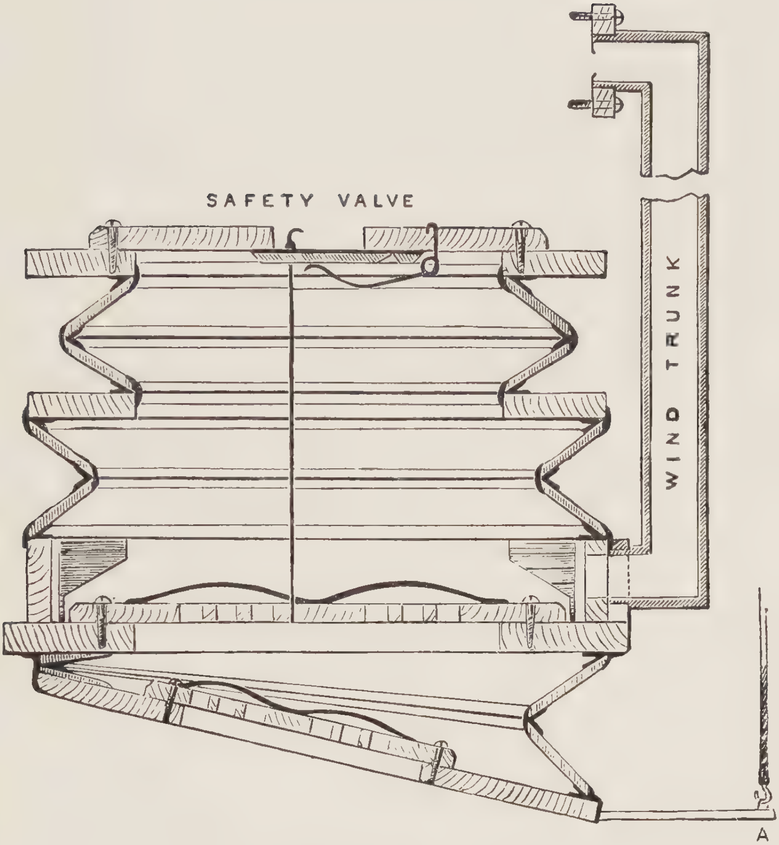


Figure 2.
Cross section of an organ bellows, showing reservoir with double folds and feeder below.

surprisingly large organs were blown by hand in the old days.*

To this same type of bellows was applied later a water motor, whose function was that which had been the duty of the bellows boy. The water motor moved the feeders up and down at a rate of speed sufficient to keep the top of the reservoir at a given height. This was accomplished by a counter-weight on the top of the bellows which was connected by a chain and pulleys to a valve in the water motor, and as the top of the reservoir was raised the counter-weight was raised with it, and allowed the valve that admitted the water to the water motor to close, thereby stopping the operation of the feeders. As soon as the organ was played and the wind started to leave the reservoir, allowing the top to go down, the counter-weight went down with it and pulled open the valve admitting water to the motor which started pumping.

---

*There has been an interesting club formed recently, under the leadership of Mr. Chet Shaefer, who terms himself "Grand Diapason" and whose organization is called the "Guild of Former Pipe Organ Pumpers." It is termed a non-essential, non-profitable organization, its motto is "Pump for the Wind is Fleeting," and the primary purpose of the organization appears to be to prove that not all successful business men started in life as newsboys. Some of the most successful have started by pumping the organ in the village church.

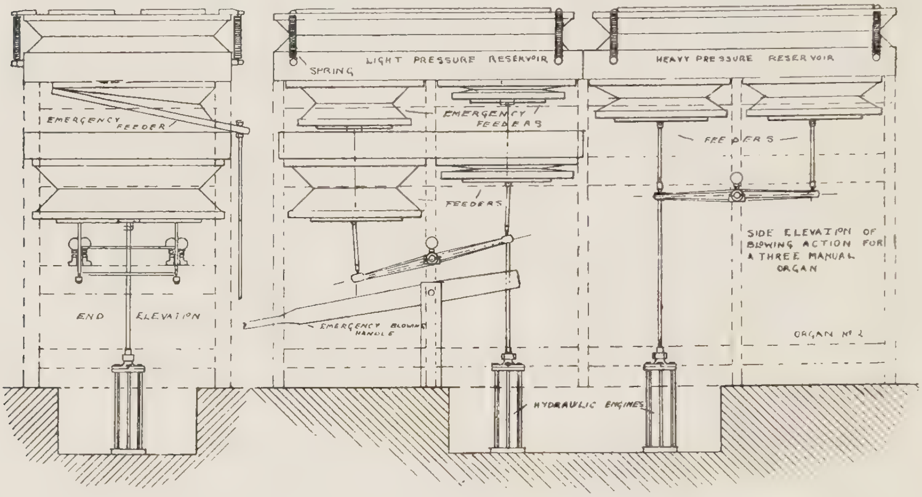


Figure 3.
Showing application of water motors to the operation of feeders.
(W. & T. Lewis, "Modern Organ Building")

These water motors were quite popular with churches, because most churches pay no water taxes (or any other taxes) and they, therefore, had the organ pumped at no expense. In consequence, even though the introduction of the rotary electric fan blower caused a great improvement in wind supply, many churches were slow to adopt it because they would have to pay for the electricity consumed. They were content to run along with an unsatisfactory, unsteady, and (usually) noisy wind supply which was the best the water motor could furnish.

An intermediate form of blowing mechanism is shown in our Figure 4. An electric motor adapted to operating the feeders by the introduction of pulleys and crank is used. The motor required direct current, so that a resistance or rheostat could be provided for regulating its speed for the varying requirements of the wind needed. There were comparatively few organs built with this type of supply. Gas and petrol engines were used in England for blowing organs many years ago, but they were seldom employed here.

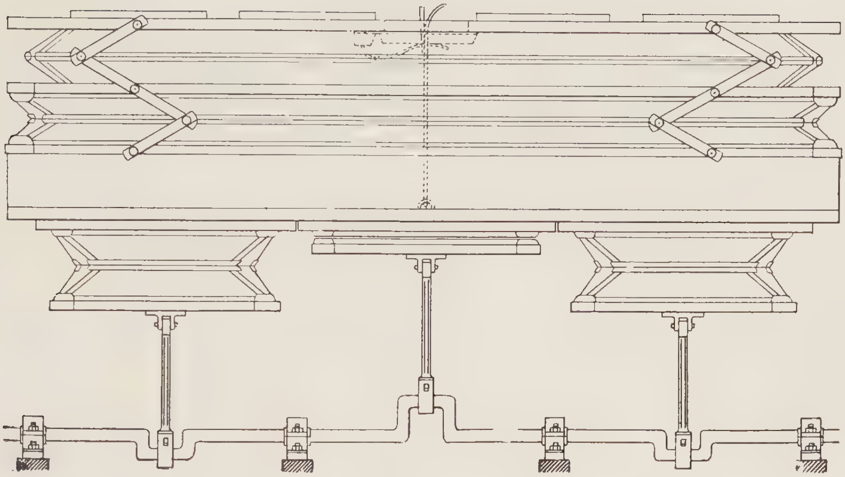


Figure 4.

The best type of three-feeder bellows. The left feeder has opened most of its distance and the right has closed part way, while the center is at the point of beginning to open. This gives an uninterrupted and jerk-less feeding of air. Note the safety valve. Drawing made by Mr. G. A. Audsley.

From either the bellows boy or water motor many churches graduated immediately to the electric fan blower. All of their blowing troubles were solved by this means and a steady supply of wind was at once made available without the noise occasioned by squeaky feeders or other moving parts in the organ itself.

Many of the younger generation of organists do not realize the difficulties that organists of twenty-five or more years ago had with the matter of an adequate wind supply. The organist had to find the bellows boy when he wanted to practice and this functionary sometimes allowed the wind to run out at inopportune times, else dependence had to be placed on the uncertainties of the water motor, with fluctuating water pressure.

The organist of the present day merely presses a button and starts to play, without giving much consideration to what happens when he does so, except that he counts on an ample supply of wind. Figures 7 and 8 show sections of modern fan blowers. It should be noticed that the fans rotate at a constant speed, usually at the speed of the motor which is directly attached to the fans on the same shaft. The supply of air that the blower furnishes to the reservoir is regulated by a valve of some sort, as for example that shown in Figure 5. When the top of the reservoir is raised, it shuts off further air from the blower. The fans then

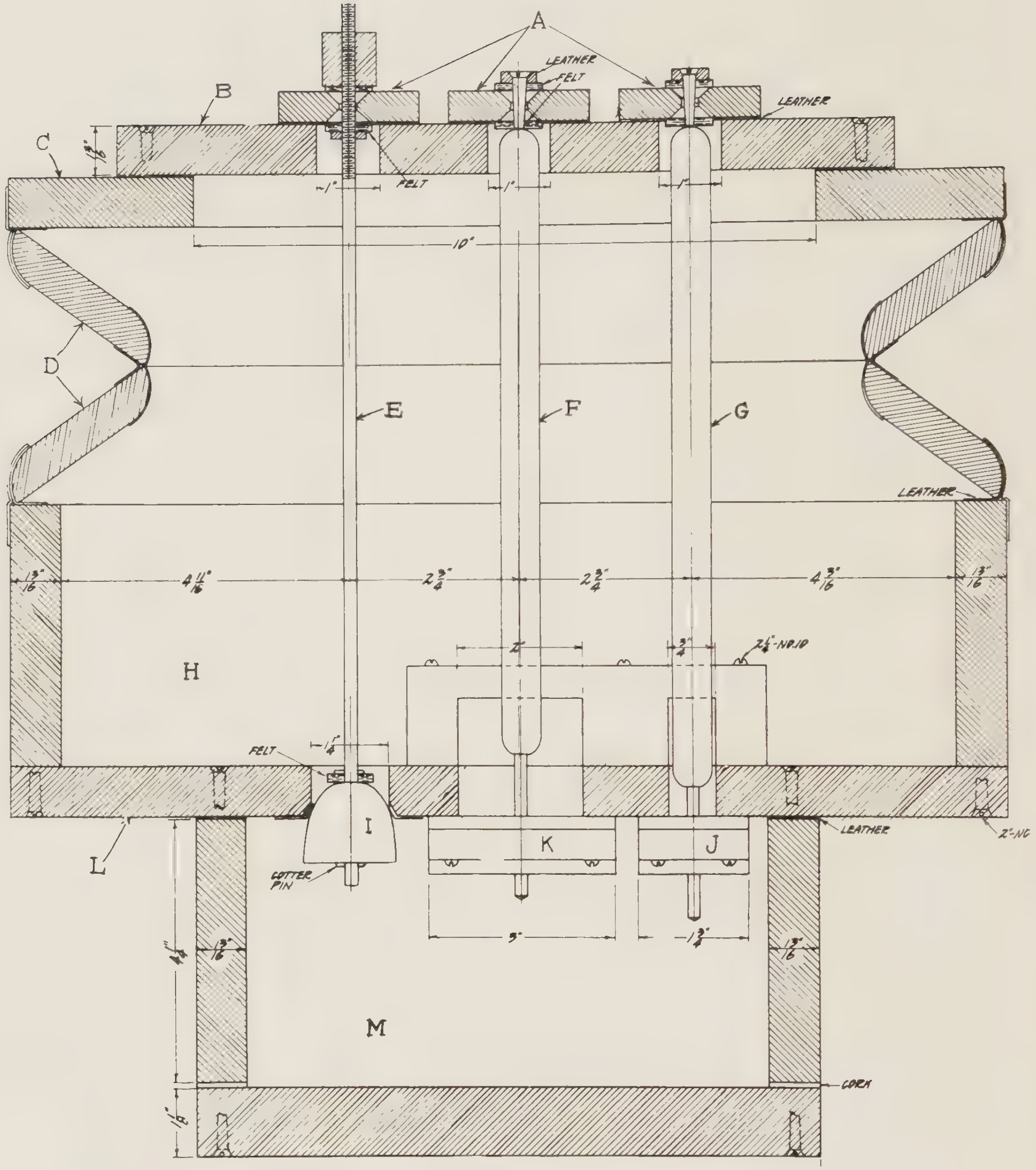


Figure 5.

High pressure reservoir used by the W. W. Kimball Co. Three control valves are used for admitting air to the reservoir from the blower, graduating in size from very small to large. The purpose of the three valves is to steady the pressure. If only one large valve is used the resistance of the high pressure wind against the valve is so great that it is difficult to draw the valve from its seat. As the top of the reservoir B, falls, the first valve to be opened to admit more wind is the cone valve I, which can be readily opened, because of its small area. As the top falls further, the pallet valve J is pushed open by the rod G. Further falling of the top board will cause the large pallet valve K to open, admitting a large flood of wind to the reservoir, sufficient for the greatest demands. This arrangement materially assists in maintaining steady pressure at all times.

merely churn up the air inside the blower and suck in very little air from the outside. As soon as air is used in the organ, the reservoir top goes down, and more air is allowed to pass from the blower to the reservoir. In reality, the term "reservoir" is not an accurate description of the function of what is left of the old bellows in the modern organ. This reservoir is merely a regulator of the pressure that the blower is capable of supplying constantly. Feeders are discarded entirely. Therefore, no such thing as an actual reservoir is required, as in the old organ where a large amount of air had to be in reserve for sudden demands made upon the wind supply, in striking or holding big chords. The modern bellows need simply to respond to the varying demands for wind by serving as a regulator to cut down the maximum supply of air that is capable of being furnished by the blower to the particular requirements of the moment.

The old type of reservoir created the proper pressure of air by having weights placed on top of the bellows. Owing to the inertia or slowness of action of these weights, the top of the reservoir could not be set into motion rapidly. When a staccato chord was played on one of these early organs with all its stops drawn, little or no response was obtained from the pipes. The air in the windchest was instantly exhausted, and no time was allowed for the inert bellows weights to fall and so to force a fresh supply of air into the windchest.

Mr. Robert Hope-Jones seems to have been the first to replace weights with springs. The use of the latter for obtaining the proper pressure has had a far-reaching effect upon organ building. It has made it possible to remove the unsteadiness of wind, from which all organs of the time suffered in greater or less degree. It has quickened the attack of the action and the speech of the pipes to a remarkable degree and has opened a new and wider field to the king of instruments. There is no inertia to be overcome when springs are used on a reservoir. The same reservoir, with the same demands for wind, will be perfectly steady when springs are used and very unsteady with weights.

MEASURING OF WIND PRESSURE

The subject of wind pressure may now be discussed profitably in some detail. Reference has been made to the fact that some surprisingly large organs were capable of being blown by hand. These were practically all of the tracker type, which, of course, require no wind for the action, but only for the Speaking Pipes. In the case of nearly all of these organs the wind pressure did not exceed three or at the most four inches. This pressure is measured by means of a wind gauge or anemometer. It is a glass tube approximately one-half inch in diameter bent in the form of a very much widened S. One end of the S tube is connected with the wind supply of the organ at a point on the windchest, usually by taking out a pipe from the top of the chest. Then, when one holds the valve below open, the pressure of air that is actually delivered to the pipes flows into the bent glass tube. The lower curve of the tube is filled with water, which, when no pressure is exerted, stands at equal level in both arms of the tube. As soon as pressure is exerted by the compressed air of the chest, the water is displaced downwards in the side of the tube that has the air pressure against it, and the water in the other side of the tube is raised a corresponding amount, as the other side is open to the atmosphere. The difference in the level of the water in the arms of the glass tube measured in inches is the wind pressure. This is the method of measuring wind pressure ordinarily employed in organ building practice.

Contrary to what might be supposed, to double the wind pressure, e.g., from three inches to six inches, requires materially more than double the amount of energy from the blowing apparatus. Consequently, organs of the tracker type that contained as many as forty stops on three inch pressure might be easily blown by a one-horse power or at most two-horse power motor, whereas an organ of this number of stops on seven and one-half inch pressure (very common for the modern organ) will require a motor of from seven and one-half to ten horse power.

Nearly all large organs have more than one pressure, some as many as ten or twelve. Two pressures are frequently introduced and the fan blowers are so built that wind of various pressures can be tapped off them for the various requirements of the organ.

If we assume in our illustrations, Figure 7 or 8, that the first fan is able to raise the pressure of the air from normal to three inches above that pressure, from thence feeding the air to the second fan, the pressure will be raised an additional three inches, or up to six inches by the second fan and so on through the series of fans, four fans being able to raise the pressure to approximately twelve inches.

In many moderate sized organs all of the stops are on one pressure. This has been standardized by several of our leading builders between six and seven and one-half inches. Such a pressure has been determined quite as much from consideration of the needs of the action rather than the pipe work, the latter other than the Reeds seldom needing more than four or five inch pressure except in very large buildings.

There is much to be said in favor of moderate pressures, those between four and five inches for Diapasons particularly, in any but the very largest organs. The greatest advantage that has accrued tonally

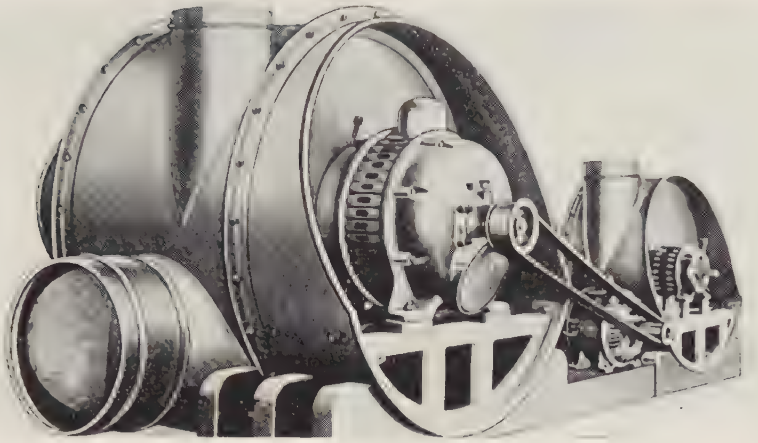


Figure 6.
40 H.P. with 2 H.P. step-up "Orgoblos" for a large organ.

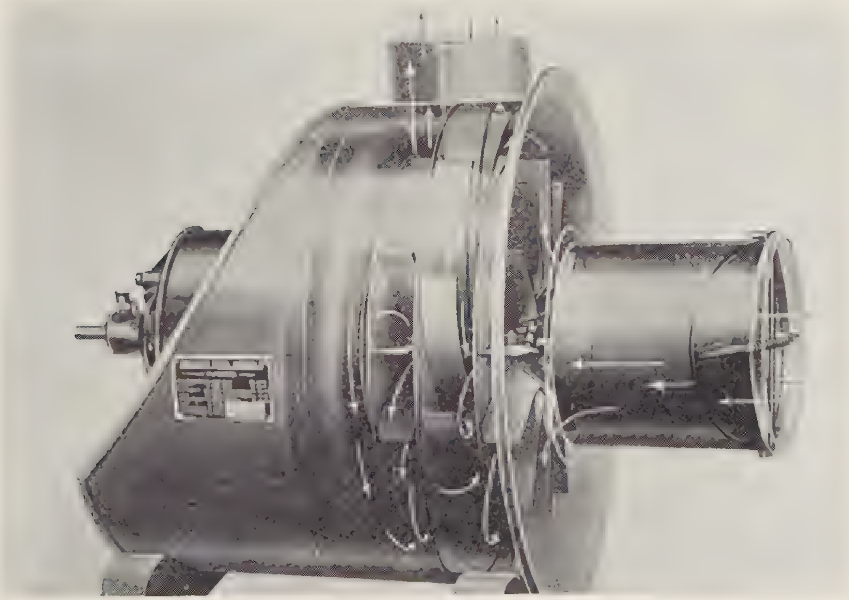


Figure 7.
Phantom view of an "Orgoblo" showing the progress and direction of the wind through two fans, with baffle plate between.

to the organ by means of increased pressure has been with the Reeds, the Chorus Reeds especially, which tone undoubtedly can be made very much more smooth, prompt, and more musical, by increase of pressure. This will be discussed later in our chapter on the Reeds in the Organ.

Increase in pressure does not necessarily mean increase in volume of sound. The Kimball Company have very thoroughly demonstrated this in the residence organ in their studio at Chicago, where the entire organ is on ten inch pressure and yet has a number of the most delicate, soft effects, such as one might suppose would be produced from pipes speaking on two and one-half inch pressure.

Large organs in the past had to be blown by one or several men. Such was, until recently, the case with the organ at Notre Dame Cathedral in Paris. These organs had necessarily to be blown on quite low pressure in order to make it possible to work them at all. To get a sufficient volume of tone without excessive demands on the wind supply made it necessary to have a large number of Reed stops on very low pressure. These were voiced absolutely "freely" to produce the maximum amount of tone on the pressure available. The Reeds in any organ take much less wind in proportion to the volume of sound they emit than do the Diapasons and large Flutes. Old organs, therefore, had few, if any, large Flutes and mostly small scaled, lightly winded Diapasons. This had to be done to conserve the wind supply, which was a very considerable problem in the case of a large organ.

Another of the great advantages of the fan blower, in addition to doing away with the feeders entirely, is that the reservoir may be of moderate dimensions as compared with what was imperatively needed when the organ was supplied by feeders. Old organs usually had one large reservoir, in some cases as large as eight by fifteen feet or even larger, to supply the requirements of the entire organ. This function is now performed by a small reservoir not necessarily more than three feet square for each division of the organ, and with a separate reservoir for the large Pedal Stops. Pedal pipes, being of large size, require much more wind and would be likely, if on the same regulator as the Manual pipes, to cause unsteadiness. It is customary at present with most of our best builders to set off the basses (or the eight foot octave), of all the heavily winded Manual stops on a separate bass chest. This causes the wind pressure on the main chest to remain more steady when heavy chords are played in the bass octave on the Manual key board. All of these devices and expedients have served to allow the modern organ to maintain a wind pressure of remarkable steadiness. This is one of the foremost requirements for the proper intonation of the pipes.

The wind is distributed from the reservoirs to the various wind-

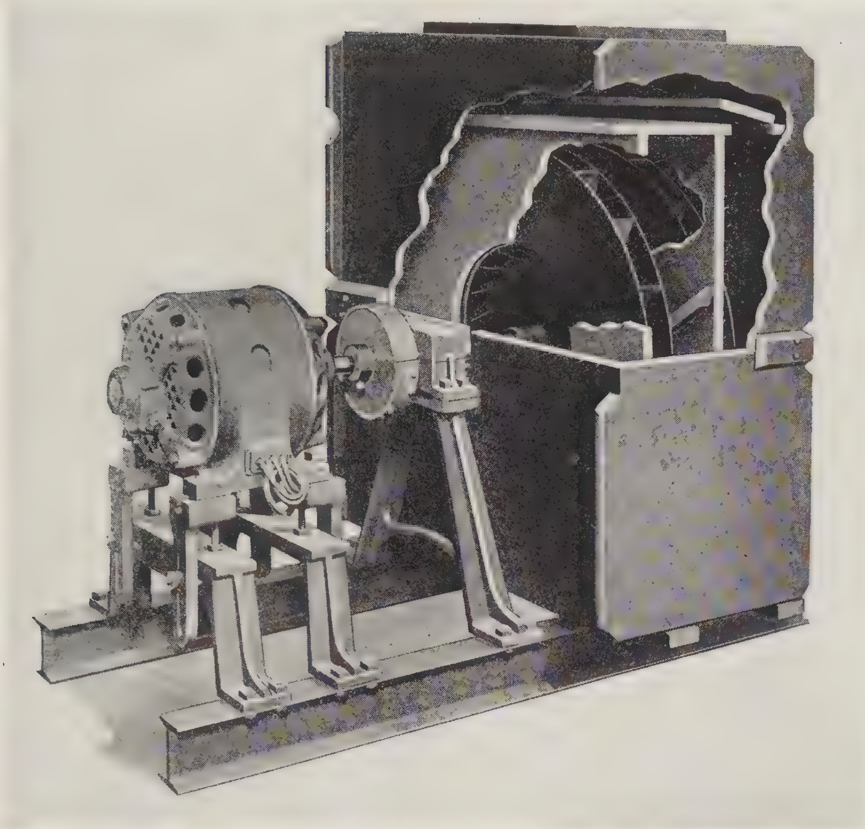


Figure 8.

The Kinetic organ blower, with a portion of the casing cut away to show the fans and baffle plate. Both the motor and the fans are mounted on one shaft, so that no belts or pulleys are required. The generator is mounted on the opposite side of the blower from the motor, ordinarily, though in some cases the generator is driven by a belt from the main shaft.

chests on which the pipes are planted by rectangular wooden conveyances, or frequently, in modern work, by round galvanized sheet iron pipes of the proper diameter to insure an adequate supply.

When there is a very long distance between the reservoir and the chest, as is sometimes unavoidable (though great distances are always undesirable), the pressure is apt to become unsteady because of the long column of elastic air in the conductor pipe. This unsteadiness is frequently avoided by the addition of a small bellows placed on the outside of the conductor with springs adjusting the motion of the top board of this so-called "concussion" bellows, so that when there is no disturbance in the wind supply the bellows remains about half way open. As soon as a sudden demand is made on the wind, this bellows collapses momentarily and then rebounds absorbing the greater part of the shock to the air column and steadying the wind pressure at the mouths of the pipes. This is a very ancient expedient that was resorted to in the days of hand blown organs, and it seems that it should not be necessary in the modern organ. Yet I have observed numerous instances where it was imperatively required to steady the wind, particularly on a large swell chest that was far removed from its reservoir.

The Austin system of building organs, where the entire air chest is made into an immense reservoir, is described in our chapter on Types of Windchests. This is no doubt the ultimate system for absolutely steady wind pressure. Its advantages and disadvantages are there explained.

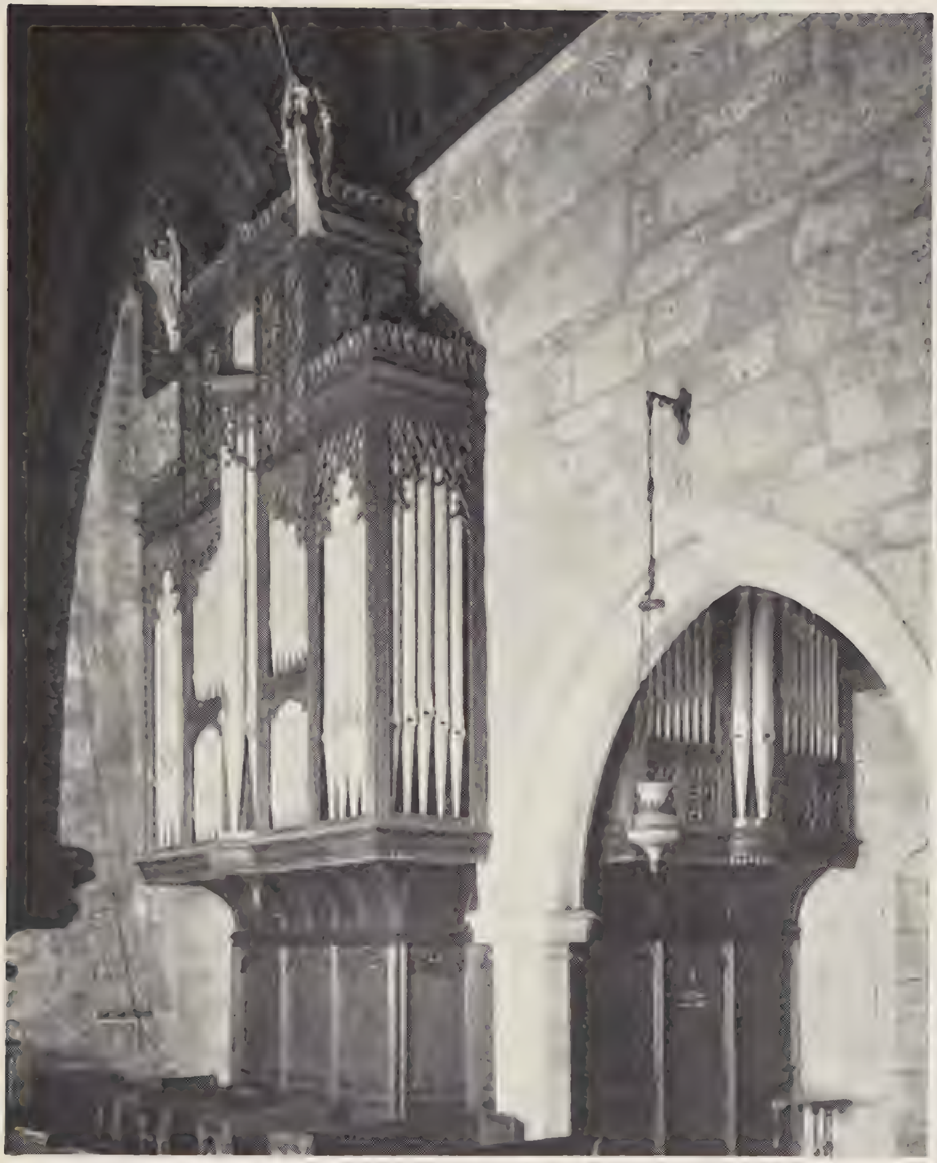


Plate IV.

"A thing of beauty—is a joy forever." Though homeliness in case-building may be only case-deep, the frailty of man still desires the element of beauty and rebels at the thought of having to use a tomahawk in generous sweeps in order to make the sight more lovely. Case-building is not a lost art and never was. If there is a lost art it is the gentle art of case-buying. Organs are made to be heard first and seen second, as a general rule. A builder who tries to paint a picture in pipes before finishing his picture in tone is no friend of the future of the organ. Yet when the buyer has the soul of an artist and the pocketbook of a banker, the organ builder finds the situation ideal and Hillgreen, Lane & Co. met the situation by building for the church of St. James the Less, Philadelphia, Pa., a small organ of such merit as to make us all pause a moment in complimentary contemplation.

(From "The American Organist")

CHAPTER 3.

THE SOUND PRODUCING PORTIONS *of the* ORGAN

IN the heading of this chapter, use is made of the terminology employed by Hopkins and Rimbault in their monumental work entitled "The Organ." This work, for its day, was one of the greatest contributions ever made to the literature of organ building. Much of its material is now interesting from a historical viewpoint only, particularly the descriptions of mechanical construction. However, some of the ideas expressed in this work on tonal structure are just as sound today as they were when first put down.

Some of our present day American builders and organists seem to think that the matter of a complete Diapason chorus on the great organ and Reed chorus on the swell organ is a new departure. It is for many American builders and many organists. It is a fact that, due to the influence of Hope-Jones and others, during the past thirty or forty years many American builders have been building, and organists have been playing, organs that were designed with very small regard for tonal build-up—but more of this in our chapter on The Tonal Structure of the Organ.

We now propose to describe the construction of those parts of the organ which have to do primarily with its tone. In later chapters the matters pertaining to tonal build-up and ensemble will be considered particularly. We will now discuss the construction of the pipes themselves, which fall into three distinct classes, viz: 1. Flue Pipes, 2. Reed Pipes, 3. Diaphones. Their shape may be either round or rectangular, long or short, broad or narrow, according to circumstances. The materials from which organ pipes are made are tin, lead, a mixture of the two with antimony metal, zinc, and wood of various kinds.

CONSTRUCTION OF METAL FLUE PIPES

Of all the materials used in the construction of organ pipes, that which ranks first in point of excellence is pure tin. It is almost indispensable in the production of the keener string toned stops. For duller toned pipes such as Metal Flutes and the Phonon type of Diapason, a very large percentage of lead is introduced. Pipe metal is made in a great variety of proportions of tin and lead melted together. Ordinary pipe metal, such as is used for Diapasons, contains about twenty per cent tin and the balance lead, with possibly some antimony for stiffening. This is the minimum amount of tin that may be used satisfactorily in pipe making, for, if a larger proportion than eighty per cent of lead is used, there will not be sufficient stiffness and the pipes will crumple upon themselves from their own weight. For ordinary pipe metal about one-third tin and two-thirds lead is used, although a better quality is forty-five per cent tin and fifty-five per cent lead.

When this much tin is used it causes spots to appear in the metal which makes what is termed "spotted" metal. These spots rise to the surface when the metal is cooling after being cast, and when the pipes are polished up they look as if they were marked all over with ink stains which had been partially cleaned off. If the proportion of tin runs high, the spots run closely together; indeed spotted metal proclaims its quality by its appearance. If the spots are very widely separated, the quantity of tin is small. Such pipes give good round tones and are very satisfactory for all metal stops where a reasonable amount of harmonic development is required, but when an excessive amount is necessary as in keen String tone, ninety per cent tin is the best metal to employ. The thickness of the metal has also much to do with the development of harmonics, or the reverse. Thick metal causes the tone of pipes made with it to be more foundational. Pipes made with thin walls have greater harmonic development.

It is a curious circumstance in connection with modern organ building, that in the production of metal pipes from the very first processes of casting the metal, through to practically the finished product, there have been scarcely any changes or improvements made in the *modus operandi* for hundreds of years.

Dom Bedos, in his great work on organ building, written nearly two hundred years ago, shows a wood cut of a metal pipe shop in those days. The tools and appliances used then, look very similar to what we see in a modern American pipe shop. The casting bench and soldering irons, the mandrels, and all of the appliances used are there shown. The only difference appears to be in the dress that the pipe maker wore, for in those days he apparently wore a wig and ruffles on his shirt sleeves, where today he is more apt to wear an apron. Even as far back as the 10th century, writers have described pipe making as being accomplished much as it is done today.

After the proportions of tin and lead have been decided upon, they are weighed out and placed in a large iron pot and the metal brought to a proper temperature for casting. The casting process is accomplished on a long wooden table or horizontal slab, usually about three feet wide and fifteen feet long. The top of this table is covered with a canvas or moleskin cloth which is stretched very tightly and smoothly over the entire top surface. The table top presents almost the appearance of an artist's canvas stretched ready to paint upon. A box is provided to run in grooves from one end to the other of the length of the table with one side of the box capable of being raised or lowered a small distance from the top of the table.

The molten metal is placed in this casting box and the thickness of the metal to be cast is determined by the width of the opening between the movable side of the box and the top of the bench. The box is then dragged from one end of the bench to the other, leaving a sheet of metal behind that has flowed out from the back of the box as it was pulled along the bench. Metal of any thickness required in pipe making can be cast in this manner. As soon as the sheet has cooled sufficiently, it may be removed and another sheet cast.

These sheets are then planed to make them smooth and this is done by planing away from the point where the sheet of metal is secured to the bench. The plane used is like an ordinary carpenter's plane only the blade is set more nearly vertically. A flat steel scraper is used for finishing and to make the metal of the required uniform thickness. It certainly seems strange that after the hundreds of years that pipes have been made for organs, that no more modern means of preparing the metal to be made up into pipes has yet been devised by any builder than to plane down the cast sheets of metal by hand. Usually the heavy Diapason metal is planed down on only one side, leaving the marks of the canvas on the opposite side, just as it comes from the casting bench, the idea being that as weight of metal is particularly desired in these pipes, it is useless to plane the sheets thinner.

Having now a sufficient quantity of pipe metal sheets cast, they are cut to the exact size and shape required for the particular scale of stop that is being built. Organ pipe shops have complete patterns of all the scales generally used, and simply cut the sheets from the patterns, both the body of the pipes and the feet.

Before going further, a few definitions should perhaps be given concerning the various portions of the pipes. Let us refer to Figure 9.

An open metal Flue pipe is composed of three distinct parts, called the body, the foot and the languid. The larger metal Flue pipes have in addition two other parts that are soldered on separately, viz., the upper and lower lips. The body is that part of the pipe that commences at the mouth of the pipe and extends to the top. It is formed by rolling a sheet of metal of the required dimensions around a smooth cylindrical column called a mandrel, and uniting the edges together with solder. The joint thus formed is called a seam, and occurs at the back of the pipe. The body of the pipe, on the opposite side of the seam near the lower end, is flattened by burnishing, forming the upper lip or leaf of

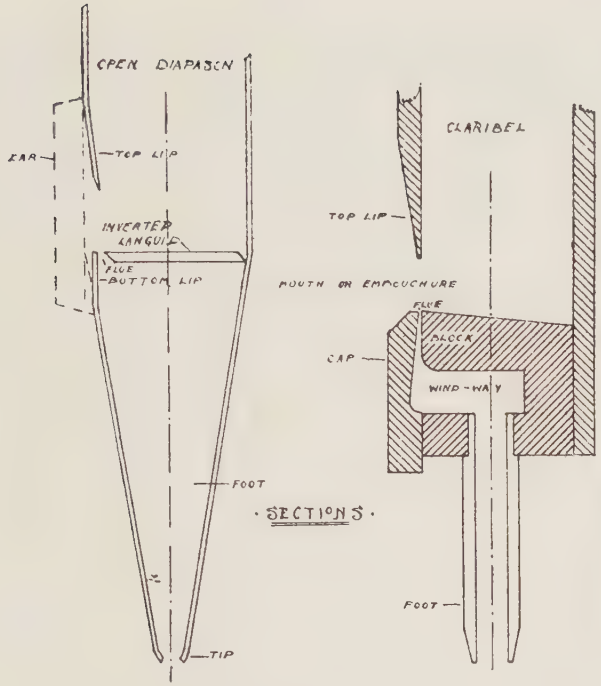


Figure 9.
Left, a section of a metal pipe. Right, a section of a wood pipe.

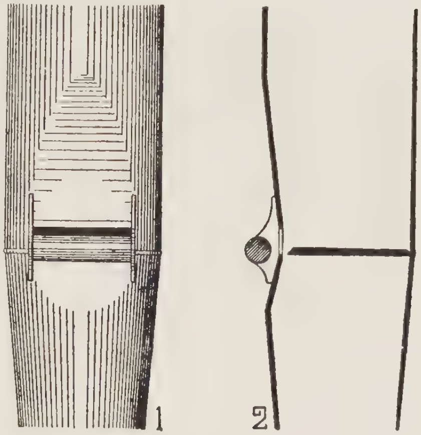


Figure 10.
1, a front view showing harmonic bridge aplied to the mouth. 2, a side view of the same pipe.

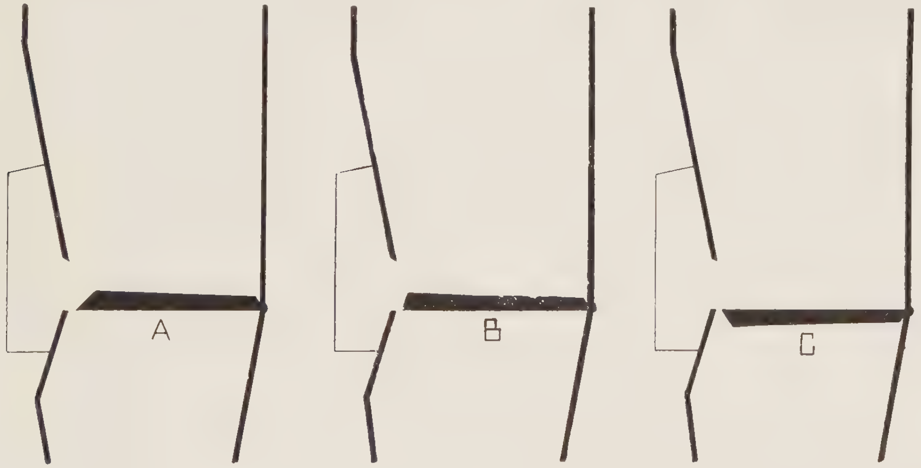


Figure 11.
A shows the normal shape of the languid in Diapason pipes. B is a languid with a more obtuse bevel, used in early English examples of the stop. C is the inverted languid.

(From Audsley, "The Art of Organ Building")

P. H. WELSHIMER MEMORIAL LIBRARY
MILLIGAN COLLEGE, TENN. 37682

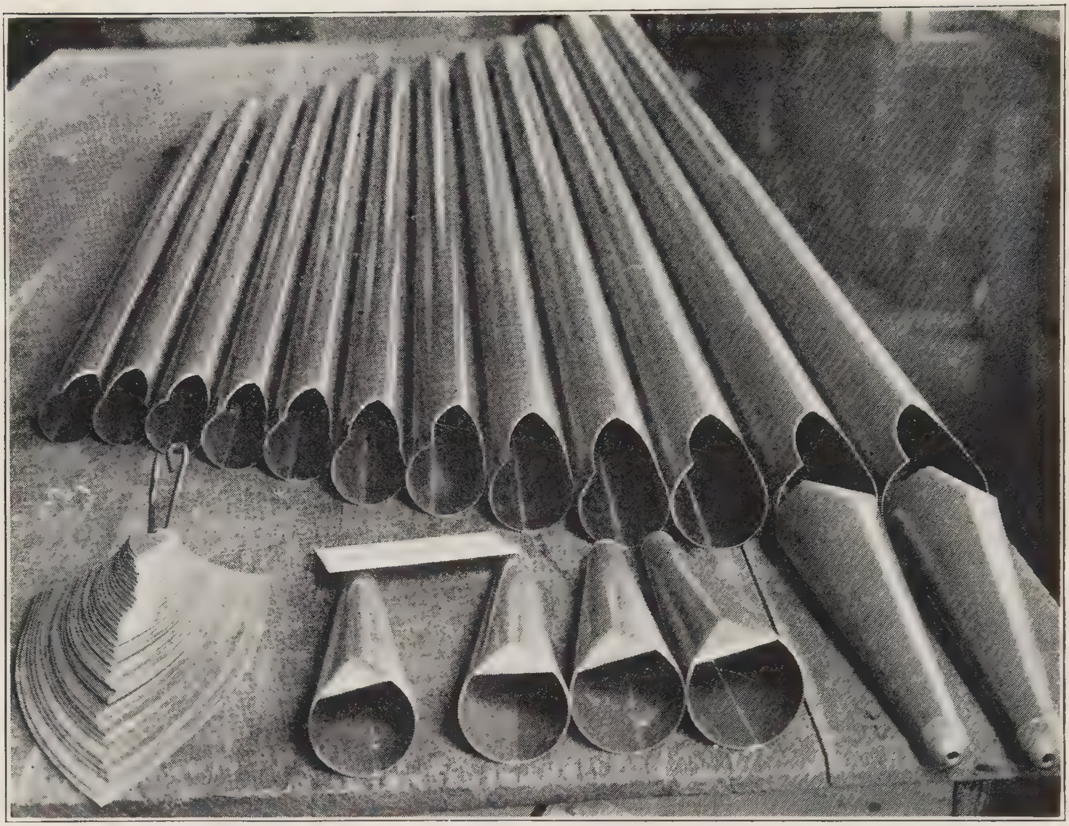


Figure 12.

Construction of metal pipes. A series of pipe bodies are here shown that have been formed around a mandrel, having previously had a portion of the lower part of the body cut away. The upper lips will be soldered onto these cuts in the body. The feet are also shown with the lower lips soldered in place. The next operation will be to solder on the languid, and then to solder the feet onto the body of the pipes. The pipes will then be ready for the voicer. Note the series of patterns in the lower left from which the upper lips are cut. The smaller metal pipes have their upper and lower lips burnished flat, avoiding the necessity for soldering on flat pieces of metal at these points. The large metal pipes are nearly always made of zinc, which requires the treatment shown above.

the pipe. A portion of this flattened part is cut away from the body leaving a broad opening. The edge that is left immediately above this opening is called the upper lip.

The foot is that part of the pipe of an inverted conical shape which extends from the mouth downwards. It is made in a similar manner to the body, that is, with the seam running vertically up the center of the back and an indentation in the front, though in this instance it is the upper part of the foot that is flattened, corresponding with that in the body of the pipe. This flattened portion of the foot of the pipe forms the lower lip.

The function of the foot is to serve as a conductor of wind from the windchest to the mouth of the pipe. Hence in the apex of the conical foot a hole is made for the entrance of the wind. The foot also serves as a support for the pipe. It is, therefore, nearly always made of zinc for the larger pipes as it has to support considerable weight, especially if the pipes are made of heavy pipe metal. Metal pipes longer than four feet are nearly always made of zinc. The common American practice is to make these pipes of annealed or softened zinc, which is much more readily worked than the unannealed or hard metal. The latter is considered better and is usually employed by the English builders. If the feet of heavy metal pipes were made of the same material as the bodies, the pipes would be apt to collapse of their own weight, as sometimes happened in old organs.

The languid is the flat plate of metal that lies horizontally on the top of the foot just inside of the mouth. It is made of much thicker material than any other part of the pipe because it is entirely unsupported, except at the sides and back. In front it presents a straight edge corresponding with the lips of the body and foot, but slightly behind that of the latter, leaving a narrow slit or windway between. The front edge of the languid is usually bevelled inwards and upwards, though certain pipes are made with what is known as inverted languids bevelled in the opposite direction. Figure 11 illustrates these two types. The languid is made strong and thick so that it will not sink of its own weight where it is unsupported in front or in the middle, in which case the sheet of wind passing from the windway would miss the upper lip and so render the speech of the pipe defective.

The mouth, as already indicated, is the hollow cut, or opening, that occurs at the junction of the body and feet of the pipe. The separate parts of an open Flue pipe are joined together in the following manner: The straight edges of the languid and the foot are first arranged parallel and then the back and sides of the two are soldered together, the narrow slit in front being left open so as to form a passage, or windway, for the

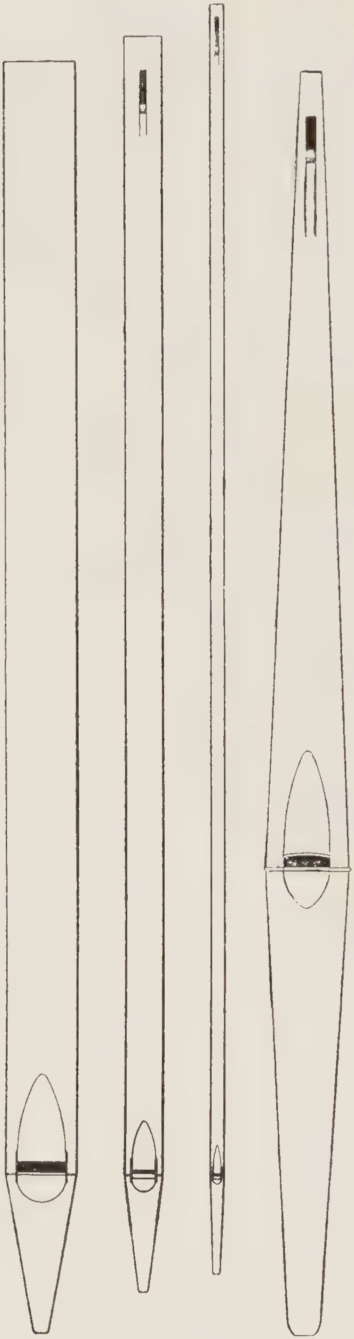


Figure 13.

From left to right, the pipes are Diapason, Dulciana, Viole d'Orchestre, and Spitz Flute.

(From Audsley, "The Art of Organ Building")

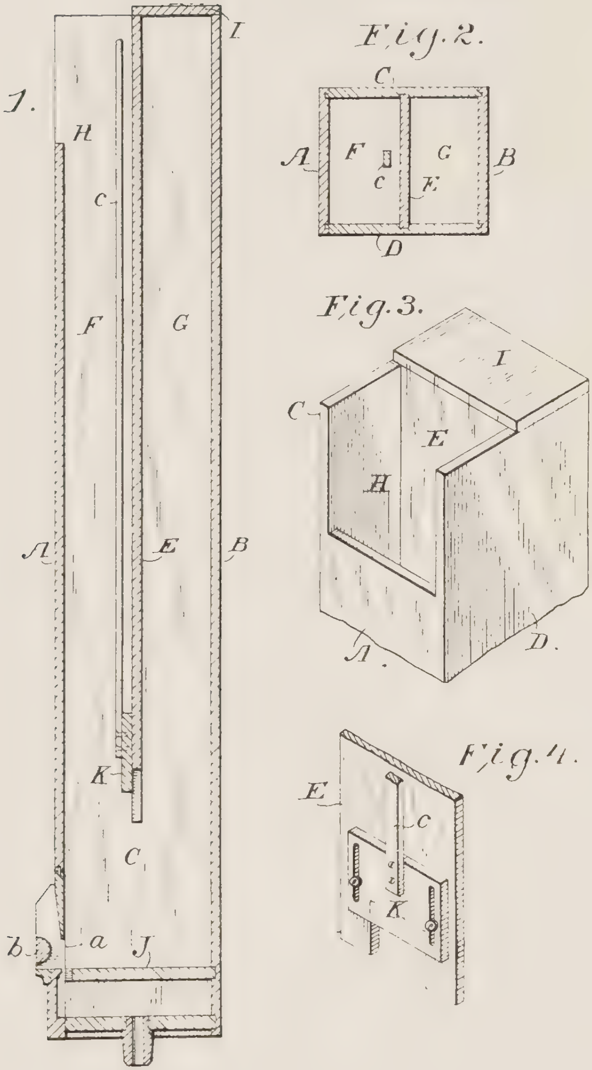
current of air that enters at the foot of the pipe. In the next place, the upper lip of the body and the lower lip of the foot are put precisely opposite each other and the body and foot are then soldered together all around. The languid is thus entirely enclosed within the finished pipe.

In making the various joints or seams, the solder is prevented from spreading to more of the surface of the pipe than is desired, by coating the pipes with whiting before they are soldered. This is easily washed off after the pipes are finished. The joints to be soldered are then slightly bevelled and scraped so that they are entirely free from whiting or grease. Candle wax has been employed as a flux for this soldering since time immemorial. This doubtless furnishes a use for the burnt down stubs of altar candles. Nearly all larger pipes or those longer than eight or ten inches have ears or pieces of metal soldered on each side of the mouth to help guide the wind sheet.

Having described in some detail how metal pipes are constructed, I should perhaps explain what causes them to sound a note after they are formed as described. In order to understand the production of sound in an organ pipe, we shall make a short study of some of the acoustical matters involved. The flute as a musical instrument dates back to extreme antiquity. The tone of the flute is produced by blowing across a hole punched in its side. In other words, it is possible to produce a tone by a stream of wind striking upon a cutting edge. In this way, by blowing across the end of any tube made of any material, such as glass, iron, rubber or cane, a tone can be produced.

The primitive flutes found in the Egyptian tombs and also depicted in the ancient hieroglyphics were made of reed or cane about fourteen inches long, possessing the usual six finger holes. When the six holes are closed by the fingers, the ground tone of the tube is produced. By lifting the fingers in successive order from the bottom end the seven notes of the major scale are obtained. By closing the holes again and blowing harder, we obtain the same scale an octave higher, by blowing still harder we may obtain two octaves higher. In other words, we are producing harmonics. It is possible to produce a complete series of harmonics from a plain tube without finger holes or valves such as the old type of French horn by tightening the lips and increasing the pressure of the player's breath. We learn from this that the pitch of the sound depends on the length of the tube and further that the pitch of the sound also depends on the amount of wind pressure. Therefore, it is obviously important that the pressure of wind in an organ should be steady and uniform, otherwise the pipes will speak a harmonic instead of the sound intended.

When a stop is labelled eight feet it simply means that the longest



SHORT OPEN WOOD DIAPASON

Fig. 2 is a cross section of Fig. 1, Fig 3 is a perspective of the top of Fig. 1, Fig 4 shows one method of tuning as at K of Fig 1.

A—front wall
B—rear wall
E—partition
F—main chamber
H—open top
J—bottom

a—mouth
b—harmonic bridge
c—tuning rod
G—complementary chamber
I—closed top
K—tuning slide

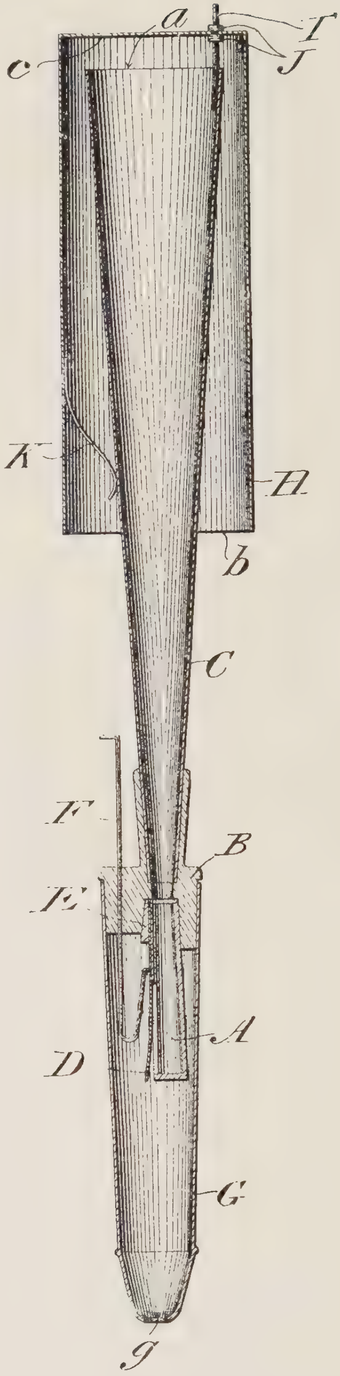


Figure 14.

Examples of Mr. William E. Haskell's short length pipes used by the Estey Organ Co.

pipe of the stop, known as CC, is eight feet long and the pitch will be the unison or normal, that is middle C on the organ keyboard will correspond with the middle C of the piano key-board. A sixteen foot stop will sound an octave lower, a four foot stop will sound an octave higher. These measures refer to pipes which are open at the top and are only approximately correct for very narrow pipes such as Salicionals and Dulcianas. Large scaled pipes do not have to be so long to produce the same pitch.

If a tube open at both ends be blown across at one end with a normal amount of wind pressure, the fundamental tone of the tube will be sounded as already pointed out. But, if the hand be placed at one end of the tube so as to effectively close it and the open end blown across as before, a sound will be heard exactly one octave below that which was heard when blown into with the top open. One of these pipes was an open pipe, the other a stopped pipe. The difference between the two is that which constitutes the two great classes into which Flue pipes of organs are divided. It is, therefore, seen that by stopping up the end of an organ pipe it is possible to obtain eight foot tone from a pipe only four feet long, and sixteen foot tone from a pipe eight feet long, but with some loss of power and volume. The harmonic series produced from stopped pipes is entirely different from that of open pipes. The latter harmonic series is produced by vibration rates per second which are in the ratio of 1-2-3-4, etc., while those of the stopped pipes have vibration rates per second which are 1-3-5-7, etc. Only the odd numbered harmonics can be produced from closed or stopped pipes.

The Estey Organ Company appear to have discovered a new principle in acoustics in their open bass pipes shown in Figure 14. The late Mr. William E. Haskell is the inventor of this ingenious type of pipe. He states, "The inserted tube or complementing chamber in the pipe is such in length as to complete the full length of the pipe. It is, as will be noticed, smaller in scale than the outside pipe. The effect is to produce a vibration that would be obtained with a full length pipe and in no way does it interfere with the quality of tone. In fact, it assists the pipe materially in its speech," according to the statement of the builders. The Estey Organ Company state that they have worked out this type of pipe for all classes of tone, Strings, Flutes and Diapasons and the law holds good in every instance.

Helmholz was the first to demonstrate that the quality of all musical tones depends entirely upon the presence or absence of their upper partials. Thus a large scaled Flute pipe has practically no harmonics present, and its tone is practically all ground tone. This is also true of the large scaled, high, narrow mouthed Diapason. The clanging tone

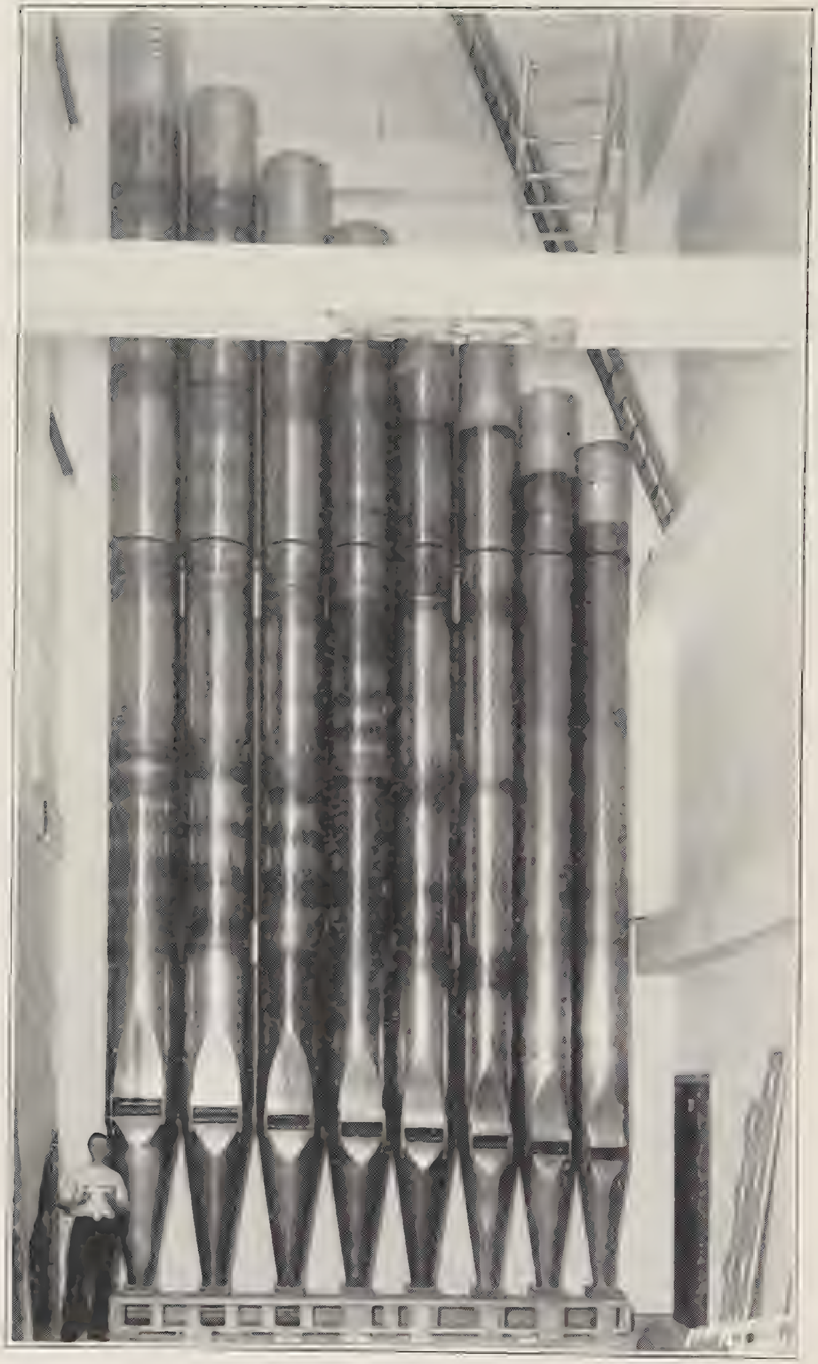


Figure 15.

The lowest eight pipes of the Metal 32′ Diapason in the Atlantic City Auditorium Organ. The Low CCCC weighs 2200 pounds and this is said to be the largest and heaviest metal Diapason ever made. Midmer-Losh, Builders.

of the trumpet has very many of the high partial tones present and an instrument like the cymbal gives us the whole of the upper partial tone series.

It will be seen from this that different qualities of tone in organ pipes are produced; first, by the thickness of the material of which the pipe is made, as well as the material itself (although this is not of so much importance as has formerly been thought); second, by the scale of the pipe; third, by the amount of wind pressure; fourth, by the shape and size of the mouth, the relation of the lip to the stream of wind impinging on it from the narrow slit, and the shape and thickness of the lip itself. This manipulation of the mouth and lip to produce the tone desired is called voicing, which will be treated in a later chapter.

Returning now to the construction of pipes themselves, we shall consider the construction of wood pipes.

CONSTRUCTION OF WOOD FLUE PIPES

The wood pipes offer a more limited range of tone than is possible from metal pipes. The characteristic tone of nearly all wood pipes is some type of Flute tone. Wood pipes are rather more simple to build and voice than any other pipes in the organ and have frequently been made with good results by amateurs. A scale is required from which the various dimensions of the pipes can be obtained, as they graduate in size from top to bottom. Wood stops may be made from almost any wood, preferably maple, mahogany or even oak; but more usually from spruce or white pine. In any event, the lumber should be well seasoned and dry, and free from knots, sap and shakes.

The first requirement in making wood pipes is the block, which will form the equivalent of the languid in the metal pipe. Having made a series of blocks of the proper dimensions (that is, the inside measurements of the stop that is being built), the blocks are shaped in any one of various ways as shown, e.g., in Figure 9. A gap is cut with a tenon saw through the mahogany or other hard wood facing, that has previously been glued on the front edge of the block, keeping the same proportion for each block. See Figures 9 and 17. Also Figures 19 to 22.

The opening at the bottom of the block is a round hole which is bored after the pipe is put together and in this the foot is inserted. The sides of the pipes are next glued to the blocks. The pieces that are cut out of the blocks are used as a guide for the sides when they are being glued on. The backs and fronts of the pipes are then glued on. The front only extends down to the top of the block and has a chamber cut for the upper lip, and an opening for the mouth, as shown in Figures

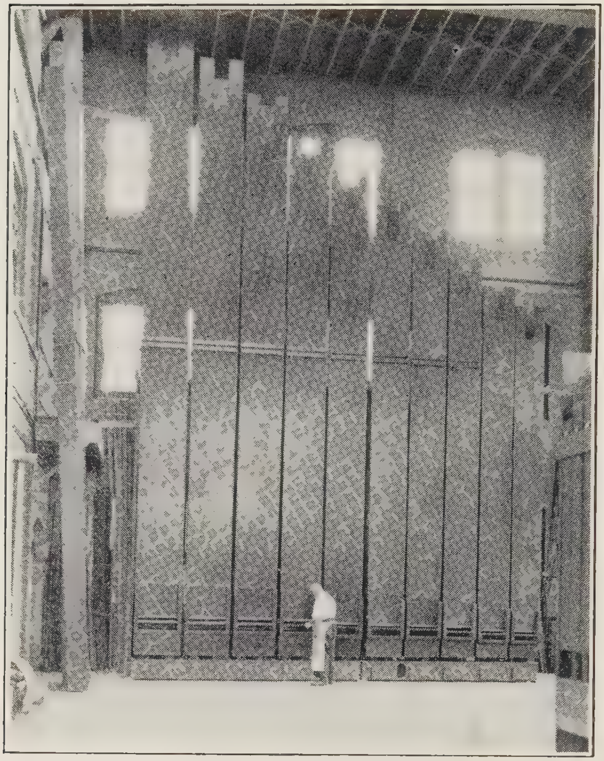


Figure 16.

The 32′ Pedal-Diapason. The largest pipe is 31-13/16″ x 28-1/16″ x 33′ long, made of sugar pine 3″ thick. (There are five 32′ Pedal stops in this Organ.) Pierre S. duPont organ. Aeolian Company, Builders.

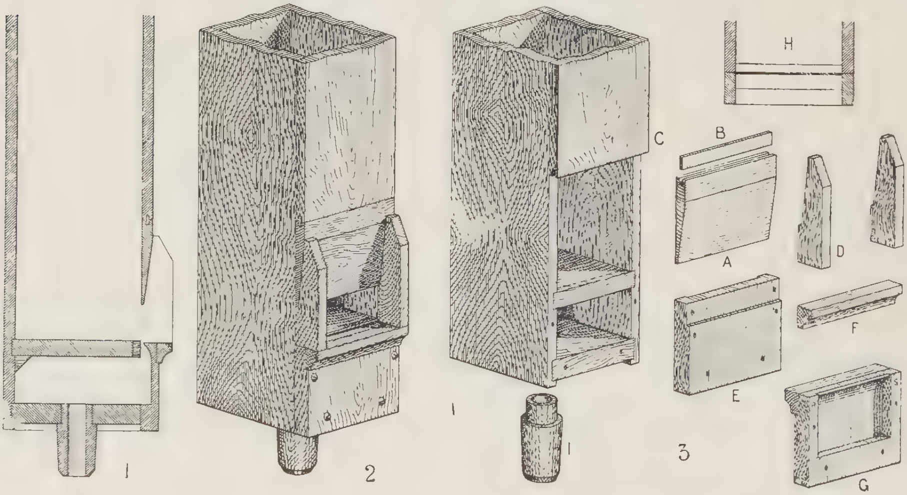


Figure 17.

Parts of a Pedal Bourdon. 1, cross section. 2, completed pipe. 3, separate parts of the pipe, as for example at A the upper lip with B the tongue grooving the lip to the body of the pipe at C. DD represent the two ears, F the beard. E and G are front and back views of the cap or lower lip.

9 and 16. The bevel is ordinarily cut about as high as it is wide, the final height of the mouth being regulated when the pipes are voiced.

The caps are pieces of wood which cover the gaps in the front of the blocks. These are usually made of mahogany or other hard wood and in the case of many Flute pipes are simply flat pieces of the same thickness as the fronts of the pipe. The windway is cut in the top of the cap before it is attached to the block and is made with a flat file. This is finally adjusted in the voicing of the wood pipes. Our illustrations show various types of Flutes and Bourdons, some with the cap hollowed out and some with the upper lip bevelled inwards, as is done in the case of the Melodia. In modern organ factories, some labor saving methods have been introduced in making wood pipes. There are large sanding machines into which the pipes may be fed and have their sides smoothed down with a great deal less labor than by planing them down by hand. There is special machinery provided for bevelling

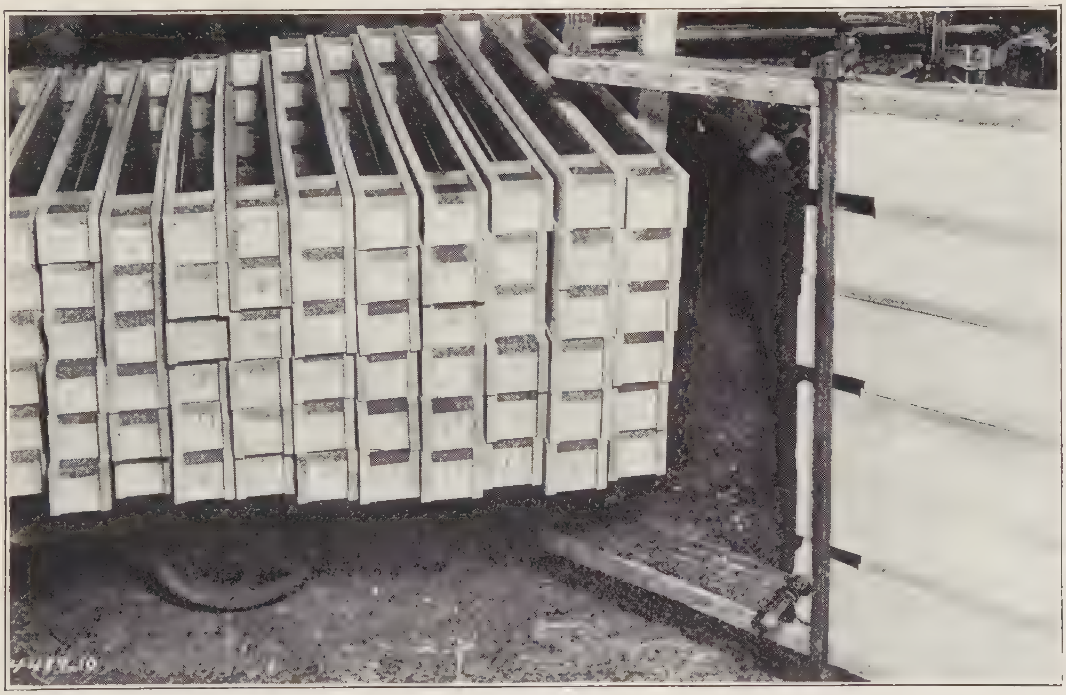


Figure 18.

Wood pipe making. The unfinished pipes shown at the right are secured in a clamp while the back and fronts are being glued onto the sides. The pipes shown on the truck have merely their sides glued on to the blocks. The backs and sides are next glued on. Wood pipes are made in nearly all factories in groups of a dozen or so stops of the same kind. This is a convenience in manufacturing.

the upper lip and for jointing the sides and fronts of the pipes before gluing so that wood pipes can now be produced more economically from a labor standpoint than was possible before the introduction of wood working machinery. No such improvements seem to have been accomplished in the manufacture of metal pipes. The best practice in the making of the larger wood pipes, such as Pedal Diapasons, etc., is to tongue and groove the joints that are glued. It is a matter of great importance to the tone of any pipe that the body be tight. If the joints of wood pipes become loose, or come open, the tone is usually ruined. It is well, therefore, to take all precautions against this. Figure 17 shows this method of construction.

Wood pipes have a coating of glue given to their interior surfaces to counteract somewhat the effects of moisture. They are usually varnished or shellacked on their outer surfaces. Paint is sometimes used, but, as this is only done to hide defects in the lumber, pipes are seldom painted by our best builders. Builders who have used good lumber want to show that they have done so by not covering the wood portions of the organ with paint or other finish that will hide the lumber. The Aeolian Company is an exception. They use the finest lumber obtainable for organ building, and then cover it with a yellow ochre compound that completely hides the wood, yet they have nothing to hide and should be proud to show any lumber they use in organ building. They consider this covering to be more waterproof than ordinary varnish or shellac.

CLASSIFICATION OF FLUE PIPES

Having outlined the general construction of both metal and wood pipes of the type known as Flue pipes, we shall give a brief account of the classifications into which Flue pipes are divided: 1. Diapasons, 2. Flutes, 3. Strings, 4. Echos, or miniatures of the first three groups. This fourth classification is suggested by Mr. Hunt in his work on the "Church Organ," and seems a very logical way of classifying the softer organ tones. I do not recall that this classification has been used by anyone before Mr. Hunt.

DIAPASON TONE

The Diapason has prominence historically, also from its importance as the essential factor in the tonal design of the organ. An organ without a Diapason is not an organ at all, consequently the Diapason may very properly be called the foundation tone of the organ and as such deserves more attention than is generally given to it. There are prob-

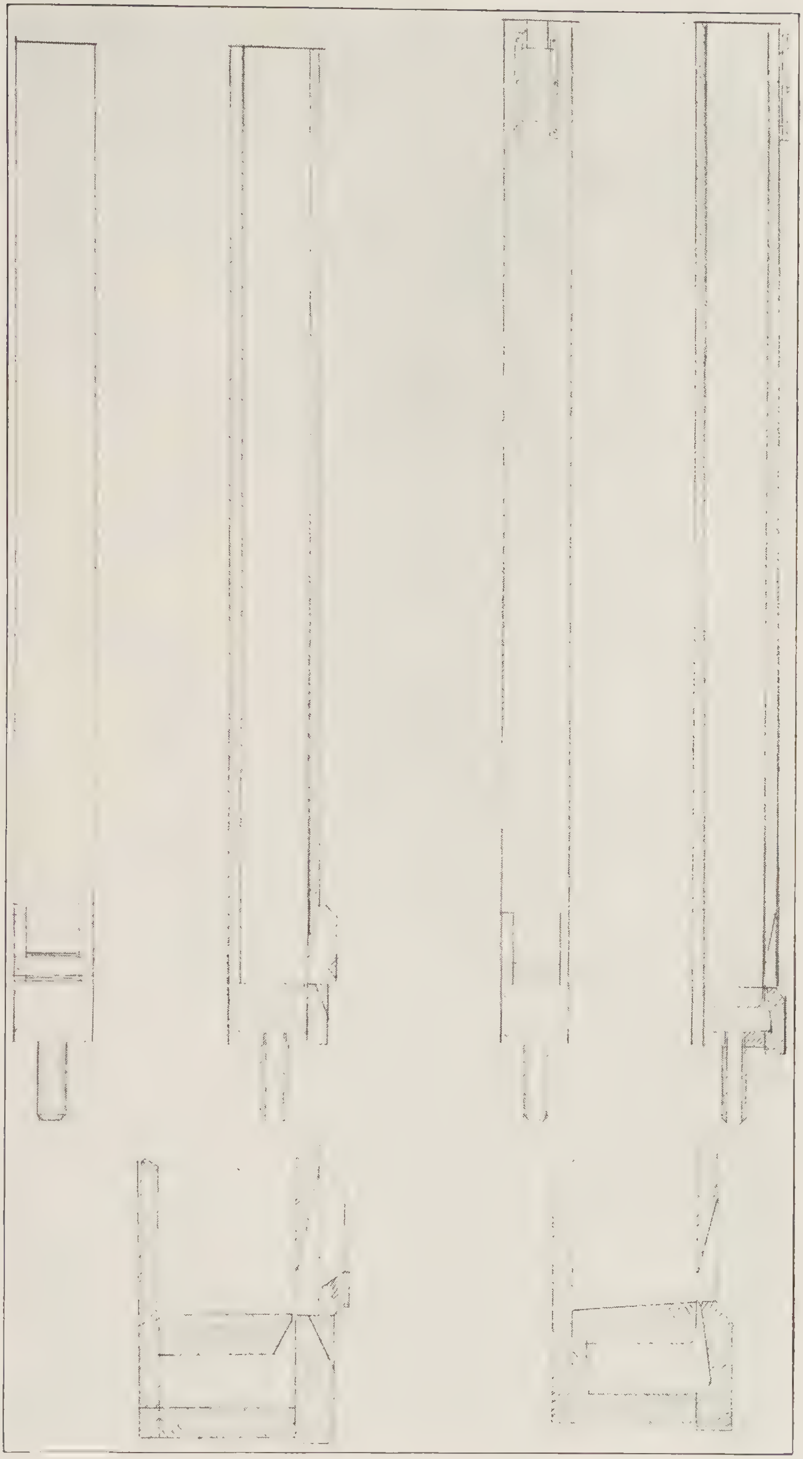


Figure 19.

On the left, front and sectional views of a Pedal Open Diapason. The triangular strip in front of the mouth is a "beard" applied to the lower notes of this stop to steady the speech and to assist the tone in generating promptly. It will be noted that it is somewhat similar in character to the harmonic bridges attached to nearly all forms of string toned pipes.

On the right, front and sectional views of a Clarabella, or large scaled flute. The tuning slide is shown at the top of the pipe.

ably as many ideas of good Diapason tone as there are builders of organs and, I was going to say, almost as there are organists, but this would probably be an exaggeration. The fact is, that the tone of the Diapason is perhaps more affected by bad or advantageous acoustical conditions than any other type of tone in the organ.

Therefore, the same builder may make two Diapasons with precisely the same characteristics and as nearly alike as two Diapasons can be. If the first one be placed in an organ where good acoustical conditions exist, organists will pronounce the tone beautiful, "an ideal Diapason tone." If the duplicate Diapason be placed in an organ where the acoustical conditions are bad, organists will consider this stop as either hard, tubby, or otherwise unsatisfactory. This obviously adds to the problem of obtaining the best type of Diapason for any given organ. Diapasons suffer greatly from bad acoustics.

The Rev. Noel Bonavia Hunt, in his very interesting and instructive treatise on the "Church Organ" (a work so undoubtedly sound, that I shall refer to it frequently in the course of this chapter and others), states that the type of Diapason known as the early English Diapason is represented by numerous examples still to be found in England in old organs of Father Smith, Renatus, Harris, Green, England, Knight (of Chichester), Snetzler, Avery, Bridge, Byfield, Jordan, Griffin, Gray, and others. Mr. Hunt states that, although all of these old examples show various standards of excellence, generally speaking they all possess the charm of tone that is characteristic to the type. He describes the tone as one of old world peacefulness, a quality which is only obtainable from pipes of the same construction and on a light wind pressure. He states, "The secret of this lies in the form of languid employed," which is shown in our Figure 11.

The tone is smooth, round, and velvety, the speech being perfectly natural and unforced. "Quality before power" must be the ruling motto adopted by the voicer of this type of Diapason. The scales are not excessive. The mouth may be 2/9 or 1/4 of the circumference and cut up 1/3 of its width. Wind pressure should not exceed 3¾ inches and lower pressure is doubtless preferable such as 2½ or three inches.

A later type of Diapason known as the Schulze Diapason was introduced in England, about 1851, by the firm of J. F. Schulze & Sons of Paulinzelle, Germany, who sent a small two manual instrument to the Great Exhibition. This led to Schulze's receiving a number of orders for larger organs, the most notable of which are those at Doncaster, Armley, Tyne Dock and Hindley. The Diapasons built by Schulze for the organs at Armley and Tyne Dock are the ones that are quoted as the finest examples of Diapason tone in England by Dr. Audsley in his

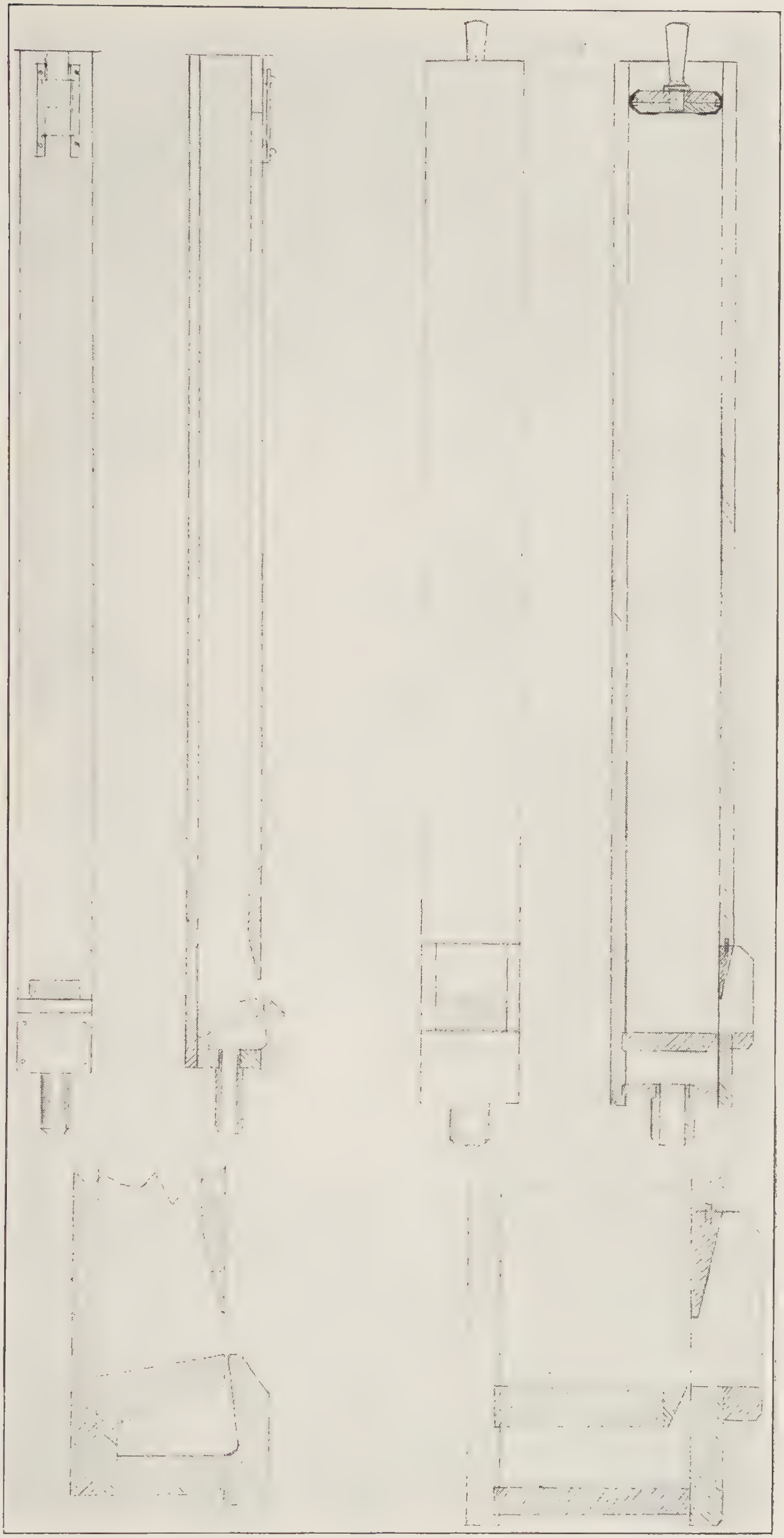


Figure 20.

On the left, front and sectional views of a Hohl Flute or Melodia. Note the inverted upper lip, a unique characteristic of these stops. On the right, front and sectional views of a Pedal Bourdon. This is provided with both "ears" and a "beard" at the bottom of the mouth to guide the wind sheet.

works on the organ. The tone is characterized as being both brighter, more vigorous and more assertive than that of the earlier English examples. Apparently at Tyne Dock, Schulze showed what he could do in the production of power and majesty of tone when it was required for a special purpose.

Mr. Hunt states, "It is not fair to judge the work of Schulze by the effectiveness of a single stop, for he was a great tonal architect and the real glory of his organs consists in the magnificent ensemble of his full Great Flue work up to mixtures, the chorus of which was treated on the same lines as he treated a single eight foot Diapason. When we speak, therefore, of the Schulze Diapason, we ought always to think of it in terms of the complete edifice of which it is an integral part." The Schulze Diapason varies in scale between 3¼ inches and 2 7/8 inches at tenor C. Such Diapasons have been copied with more or less success by modern builders. Several examples of this stop have been introduced into American organs recently, notably the Atlantic City High School organ and the organ at St. Marks Church, Philadelphia.*

It is true that the early English organ builders were very much influenced by the German builders and their work. Not until we come to "Father" Willis do we have a dominating English influence on tone. The chorus Reeds that "Father" Willis produced at St. George's Hall, Liverpool, were more revolutionary in their effect on organ tone in England (and later on in America) than any thing that has been done before or since along tonal lines.

The modern foundational type of Diapason was evolved because of the desire for abundance of unison foundational tone which Mr. Hunt believes to be characteristic of the English race, for in Germany and France even large organs possess only a small amount of flue foundation. Mr. Hunt says, "The modern English organist is not content to restrict his tonal diet to a feast upon the beauties of either the early English or the Schulze Diapason, but demands to be served with something more solid. He complains that the early English type is inadequate to cope with the heavy pressure Reeds of the modern organ, and

---

*An anecdote is told me by Mr. Maurice Hardy, for many years associated with the Kimball Company of Chicago. He frequently would discuss organ tone with Mr. Joseph Carruthers, an Englishman in the factory. Mr. Carruther's idea of the only perfect and satisfactory organ that he had ever heard was that in St. George's Hall, Liverpool, built by "Father" Willis in 1855. Whenever he did hear a particularly effective American organ, he would tell Mr. Hardy it sounded almost as well, or at least reminded him of St. George's Hall, Liverpool. No American builder could possibly do as well as the English builders. Finally, one day Mr. Hardy suggested to Mr. Carruthers that he might be mistaken, but it was his impression that the three greatest of the earlier English builders were Father Schmidt, Snetzler and Schulze, whose names after all do not sound so English.

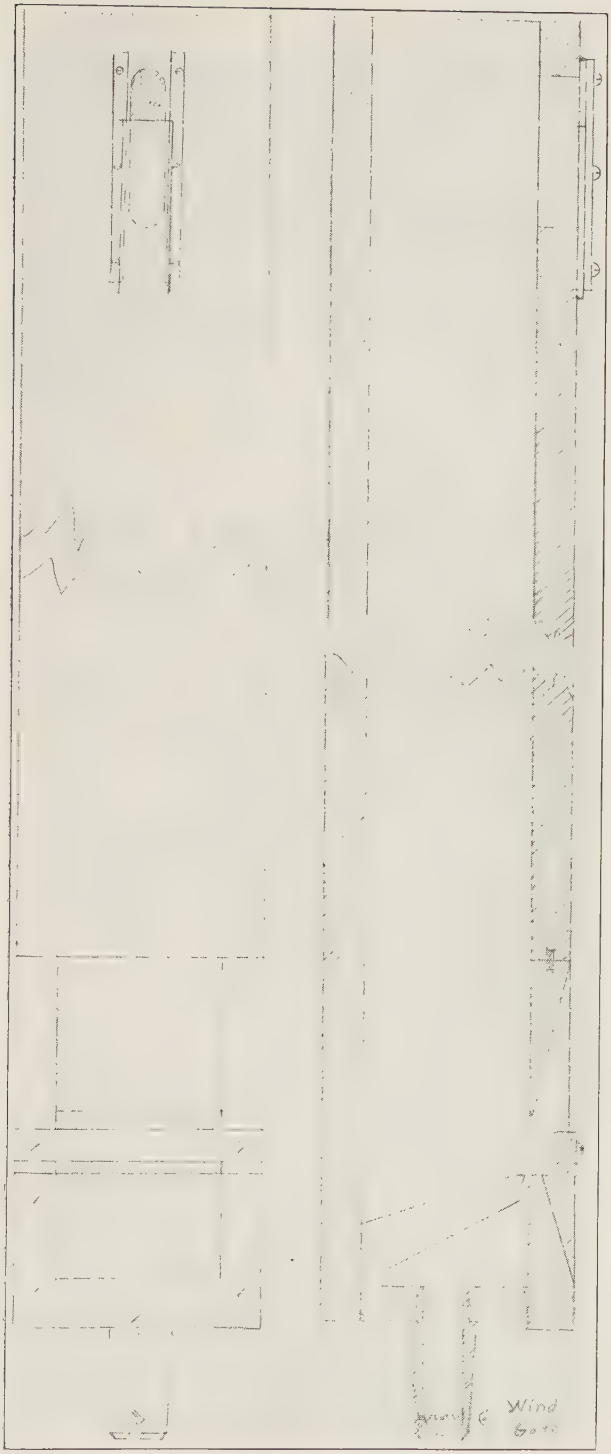


Figure 21.

Front and sectional views of a Pedal Violone. Note the harmonic bridge in front of the mouth. The scale of this stop is smaller than that of the Pedal Diapason, and the block is treated differently. Also the upper lip is made separately and is tongued and grooved onto the front of the pipe. This tongue and groove construction is employed by our best builders in joining the sides with the front and back of wood pipes also. Such a practise makes for durability of the joints.

that the Schulze type is more brilliant than foundational. What is considered to be ideal is the foundation and refinement of older examples magnified to the power of the Schulze Diapason." This has resulted in various types of Diapasons, probably the most objectionable of which was that produced by Hope-Jones, known as the Phonon type.

If we were to believe what is stated in "The Recent Revolution in Organ Building," a work attributed to George Laing Miller, we would consider that the Phonon type of Diapason was the most important invention in modern organ tone. As early as 1887, Hope-Jones introduced his discovery that, by thickening and leathering the upper lips and narrowing the mouth and increasing its height and the thickness of the body of the pipe, pipes could be voiced on ten, twenty or even thirty inch wind without either hardening the tone, forcing, or producing windiness. This type of tone was considered to be vastly preferable to what Hope-Jones termed the hard and harmonically bold Diapason, into which the Schulze type had evolved.

Mr. Hunt, who has great experience and a vast fund of information, by listening to practically all the examples of Diapasons that exist in English organs, states that in preference to the Phonon type as developed by Hope-Jones, he greatly prefers medium scaled pipes, not exceeding four inches in diameter at tenor C with $\frac{1}{4}$ width of mouth cut up 1/3 of its width, with either A, a reinforced upper lip, or B, an upper lip burnished on both edges, with a wind pressure not exceeding $4\frac{1}{2}$ inches. The object of burnishing the upper lip is to eliminate the higher dissonant upper partials, without unduly curbing the first two. The difficulty with the Phonon type of Diapason is that the first two upper partials are not sufficiently developed. Moreover, it is difficult if not impossible to build up a complete Flue chorus on the Phonon type of Diapason. The upper work (principal, 15th, 22nd and mixtures), must be restricted to the point of negligibility or else if properly developed it will create an hiatus, by standing away from the unisonal foundation tone. As a matter of fact, Mr. Hunt's type of Diapason is a somewhat modified Schulze Diapason with slightly less harmonic development.

It is undoubtedly true that more assertive upper work is possible with a type of Diapason tone with more harmonic development than one that is practically all foundational. Many American organists still seem to prefer this latter type. Because upper work mixes so badly with the Phonon Diapason, Mixtures were largely eliminated in American organ schemes for the past thirty years, in fact ever since these flutey, smooth foundational Diapasons became prevalent. Recently there has been a tendency to introduce more upper work, and the type

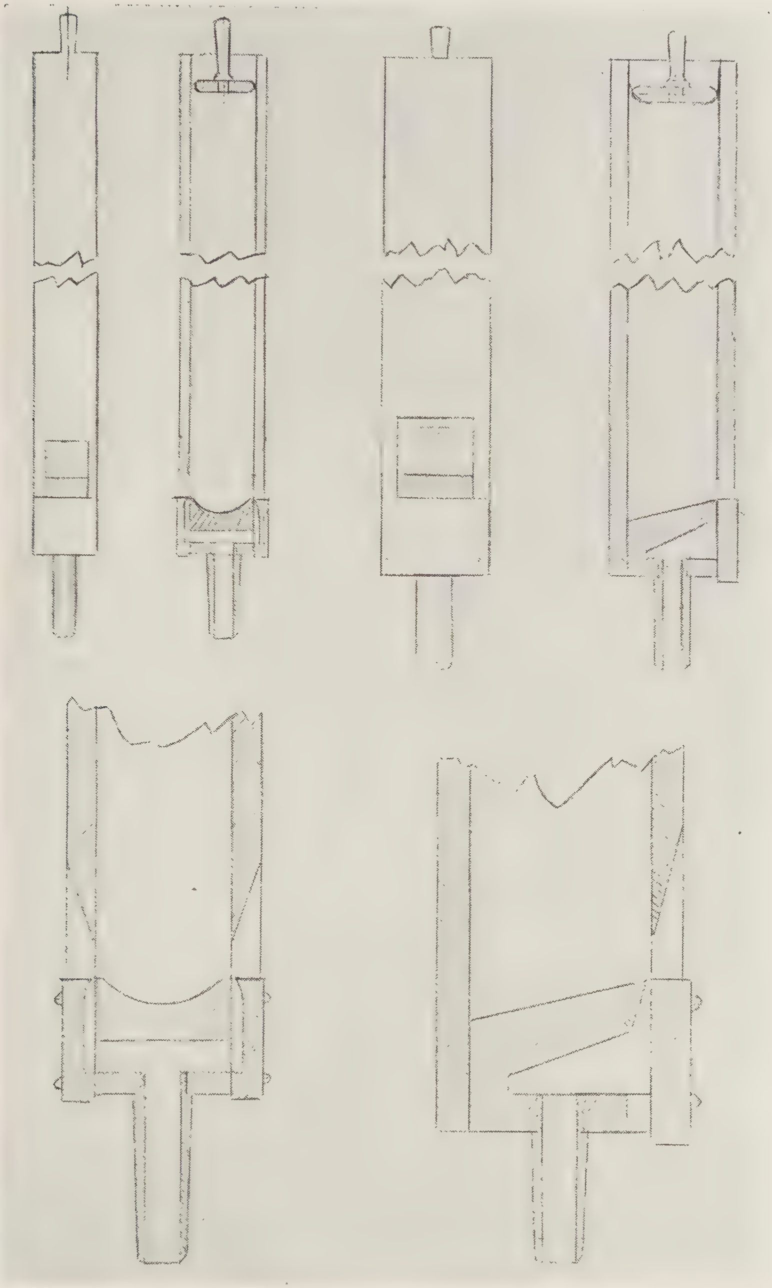


Figure 22.

On the left, front and sectional views of the Doppelflöte. This stop is generally made with stoppers in the top, but may be made with open pipes. In either case two mouths are provided on opposite sides. The pipes are normally narrow on the sides which contain the mouths. On the right, a Gedeckt. This is a modified and small scaled form of Stopped Diapason or more properly Stopped Flute.

of Diapason to go with this must necessarily have more harmonic development even though the tone border on being hard.

A small scaled Diapason is frequently introduced into organs, which develops the upper partials without actually being a String stop. The principal varieties of this type of Diapason are the Viola Diapason or Geigen Principal. The scale is usually not over 2⅝ inches at tenor C. The harmonic development is increased by the pipes being slotted, that is, by cutting out a slot near the top of the pipe for tuning purposes. French builders commonly slotted all their Diapasons.

The more foundational type of Diapason is tuned by having a sliding collar or sleeve affixed to the top of the pipe which may be knocked up or down to tune the pipe to the correct pitch. The sleeves should properly go entirely around the circumference of the pipe, so that no break or other irregularity occurs at the top.

The Salicional Diapason, usually termed Salicional, sometimes Viola, is a very small scaled Diapason which borders more on String tone than Diapason. Being very lightly winded, it affords a delightful contrast to the other principal types of Diapason.

The Gemshorn is a stop made with conical pipes with a diameter at the top varying between one-half and one-quarter of that at the mouth. This type of tone is somewhat of a hybrid, containing something of Diapason, String, and Flute, and possesses a beauty all its own. It has marvelous mixing qualities with Flute tone, giving a little edge to the tone. When such pipes have a moderate taper and the mouths are cut fairly high, the tone is described as a Spitz Flute.

The Pedal Diapasons are generally made of wood, though when I was in England I heard a recent Willis Pedal Diapason made of hard rolled zinc, fairly liberally scaled (about twelve inches at sixteen foot C). These pipes were quite equal and in some ways superior to pipes made of wood, the tone produced having greater definition than the more conventional wood Diapasons; a real advantage in Pedal tone, that is all too likely to be muddy and ill defined.

The sixteen foot manual Diapason is frequently of metal with much smaller scale, generally not exceeding eight inches at sixteen foot C. When the bass-portion of the manual stops are made of wood, the wood portion is generally not carried up past GG♯ and the break between wood and metal can be rendered quite imperceptible.

The upper work of the Diapason consists of the Octave, 15th and 22nd, and the mutation work, that is, ranks of pipes sounding a note of a different pitch from the foundation. Mutation work includes the Quint, Tierce, and Septime and their octaves. The combination of octave and mutation ranks are known by the generic name of "Mixtures," which are

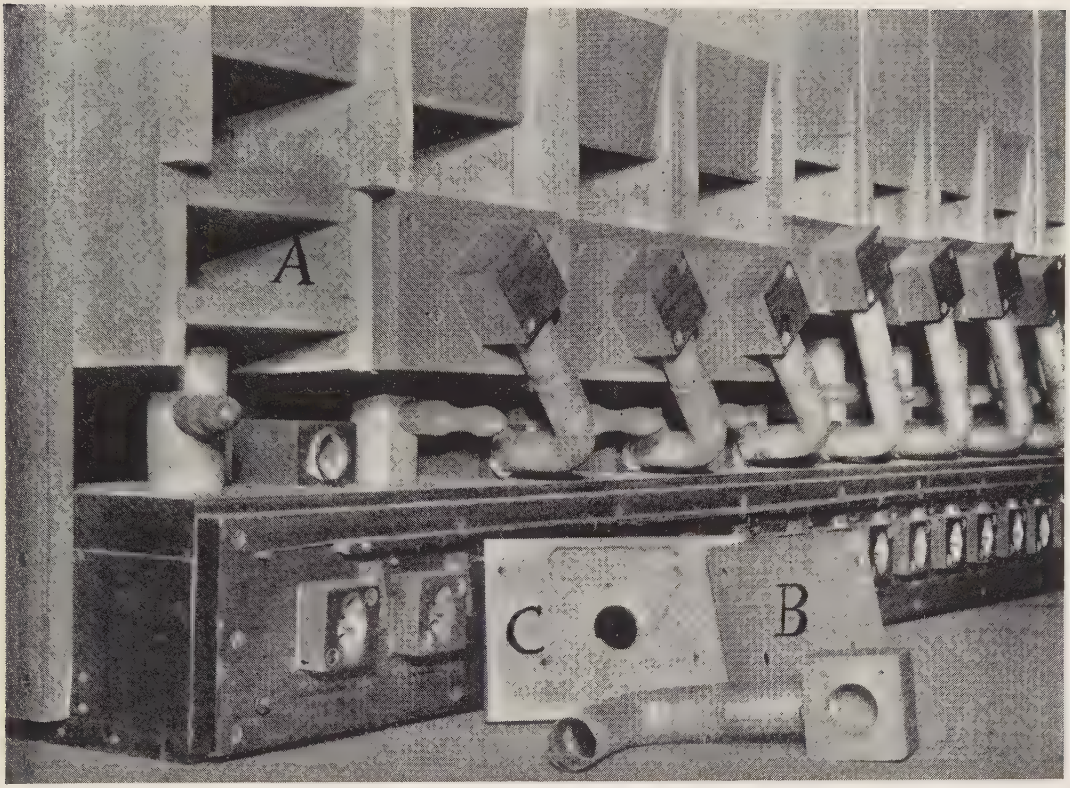


Figure 23.

The Polyphoned Bourdon-Gedeckt. An invention of the late Robert Y. Barrows. The Bourdon is supplied from the main windway A, in the left pipe shown uncovered; over this is placed the wood plate B, and the Bourdon is complete. Into plate C is cut the smaller wind-way with its narrower slit scarcely visible in the photo; when mounted on the pipe as shown in the photo, the Gedeckt is produced by this smaller supplementary cap and wind-way. "The Gedeckt is not simply a part of the Bourdon but augments it noticeably, probably because of the increased stiffness of the wind-reed. When the polyphoned pipe is properly built it produces two tones of different dynamic intensity but of absolutely identical pitch and perfect steadiness." Note the double set of magnets required. This system is employed by the Rochester Organ Company.

more fully described in our chapter on Mixtures. Organ builders made it a rule to scale and voice these octave pipes as extensions of the unison Diapason. This caused the upper work to be too brilliant and important in the general balance of the organ. More particulars in regard to the scaling and formation of the pipes comprising the upper work of the Diapason will be given in our chapter on Mixtures.

FLUTE TONE

The second general class of organ tone is that known as Flute. Under this heading are grouped all those stops in the organ whose tone is characterized by a deficiency of upper partial tones. This type of tone is obtained from stopped pipes and from open wood pipes with square blocks, from open metal pipes with very high mouths and from double length open or stopped pipes that are blown to sound their harmonics. Stopped pipes are made of either wood or metal. The principal type of stopped wood pipes that was most common to organs in both England and America is that known as the stopped "Diapason," being a large scaled pipe with a square block and hollow cap fitted a trifle below the level of the nicked edge of the block. This has been modified by Schulze into a smaller scaled pipe known as the Gedeckt. The latter pipe produces a brighter and more interesting tone of good body. The metal Stopped Flute is a thick metal pipe fitted with a wooden stopper with a high mouth and the upper lip pulled outwards, frequently by not flattening the upper lip at all, but allowing it to maintain the natural roundness of the body of the pipe. There are many kinds of stopped Flutes, including those with two mouths, one on each side of the pipe, known as the Doppel Flöte. The Quintaton is made of metal with a very low mouth which causes the pipe not only to sound its prime but its 12th, with almost equal prominence, at the same time.

The most important Stopped Flute in the Pedal organ is that called the Bourdon which has been made of inordinately large scales, as much as ten by twelve inches. A large scale is necessary to counterbalance the effect of a low mouth in order to avoid the distressing "cough" which would otherwise precede the speech of such a pipe. Usually nothing is gained by a scale larger than seven by nine inches, when heavily winded.* The 32 foot Sub-Bourdon is rarely a success below GGGG, because of the fact that any attempt to get the wind to reach the upper lip makes the pipe speak its 12th. The pipes below this are nearly a total loss, except in the most advantageous placing where there is ample speaking room. Mr. Skinner has built several 32′ Bourdons which he terms, Sub-Bass, of huge scale that are very successful.

---

*I recall an incident where one of our builders had completed the entire 32 foot octave of the Sub-Bourdon and the organ was being examined by several interested enthusiasts who attempted to listen for the tone produced by the low C. Finally, by rummaging through the organ, the low C pipe was discovered and my friend, being asked if he heard the note, said he felt only "an expensive draft."

Open Flutes comprise the following principal varieties of pipes, Clarabella, Major Flute, Melodia and Harmonic Flutes.

Hope-Jones developed a very large scaled Clarabella with a leathered lip that he termed a Tibia Plena. Metal open Flutes are made by cutting up the mouths of Diapasons until Flute tone is produced. That is until practically all the harmonic development is removed from the Diapason. This is almost exactly what is done in the Phonon type of Diapason with its exceedingly high mouth. It is more like a Flute than a Diapason. The Major Flute is simply a large scaled Clarabella and is frequently an extension of the Pedal Diapason in modern American work. The Harmonic Flute usually is made with double length pipes, overblown to speak their octave from about middle C upwards. This type of pipe produces the nearest imitation of the orchestral Flute. Harmonic Flutes were invented and extensively used by Cavaille-Coll.

STRING TONE

String tone is obtained from pipes which are especially scaled and voiced to give chief prominence to the upper partials at the expense of ground tone. String tone stops, therefore, present a complete contrast to the Flute tone stops, while the Diapason in its equipment of overtones should stand more or less midway between the two.

String tones are usually produced from metal pipes, though in many European examples, beautiful string tone is produced from wood pipes. William Thynne, an English voicer and builder, is usually given credit for the greatest modern development of string tone. The fundamental principles of voicing string tone pipes are briefly these: 1. Small Scales; 2. Bridges or Rollers applied to the mouths of the pipes which have been previously made to speak their octave or 12th. To produce the viol type of tone, the largest scale that can be employed is about three inches at eight foot C.

William Thynne's usual scale was 2½ inches at 8 foot C
1½ inches at Tenor C
15/16 inches at Middle C.

Scales smaller than this have frequently been introduced by others. It should be pointed out that these small scaled pipes must necessarily diminish in a very much slower progression than that of the Diapason pipes. The latter halves its diameter on the 16th or 17th pipe, while Viols halve on the 20th to 22nd pipes.

High pressure wind is advantageous in voicing String tone. It permits the mouth to be cut up higher and the speech to be quickened. The precise fixing of the bridge or roller is a matter that has to be learned from practical experience. The pipes are voiced to overblow, or sound their octave, like harmonic Flutes. In the case of very small scaled pipes, they are usually overblown to sound their second harmonic or 12th, and then the roller is adjusted in such a way as to bring the note back to its prime or fundamental tone. In this manner the prime tone and upper harmonics are locked together and produce the required string tone.

String tone pipes are nearly always slotted, and the modern method is to spring a set of tin plated slides around the bottom of the slot that can be knocked up or down any number of times as the pipes require tuning, without danger of breaking. When the roll of metal that is cut from the slot is allowed to remain at the bottom of the slot and is used for tuning purposes by being rolled up and down, it will eventually break off.

The miniatures or echoes of the three classes of tone that have been described consist first of the Dulciana, which is an Echo Diapason, though some modern Dulcianas tend to string tone to such an extent as to be classed in this category. The softer Flutes are the Flauto Amabile, Flute d'Amour and Flauto Dolce. The miniature String tones are the Echo Viol, Echo Gamba, Aeoline, Viole Sordine, or Muted Viol, and all forms of soft toned Strings. Some of them have a most ethereal effect. Nearly all types of string tone may have associated with the principal rank, an additional rank tuned sharp or flat, known as a Celeste Rank. This is more fully described in our chapter on the Tremulant.

THE CONSTRUCTION OF REED PIPES

UNTIL recent years, many small American organs were built without any Reed pipes, except perhaps an Oboe. This was not the case with French or English organs. The value of Reed stops was early recognized and employed to some extent in these countries. It is true that on the whole the old style low pressure Reeds introduced into American organs were not very successful from a tonal standpoint, nor in the matter of staying in tune. The reed tongues themselves had to be made of such light weight brass to produce any tone on the very light pressure employed that the result was likely to be thin and nasal. The Trumpet stops particularly sounded like "fish horns." Such a stop was only tolerable with the full organ.

In America some builders still hesitate to introduce Reed tone freely, and frequently build a fair sized three manual organ with no more than an Oboe and Vox Humana. This seems incredible, in view of the fact that (with modern high pressures available) Reed tone of all varieties can be produced of the smoothest and most characteristic quality anyone could desire. This is true if the pipes are properly made and voiced. Also, with the heavy tuning wires and much thicker reed tongues that are now employed, the Reeds will stay in tune nearly as well as the Flue pipes. The author is especially partial to all types of Reed tone and believes that one-third of all pipes should be Reeds, either Chorus or Solo, for a fair average. This is about the proportion employed in French organs, and is much higher than ordinarily used in America. After all, Reed tone can be made the most interesting and characteristic of any tone in the organ. Good Reeds, and as many of them as possible, are invaluable in giving character, variety, and distinction to organ tone.

The greatest enemy of Reed pipes is dirt of any kind. It may enter the pipes through the wind supply if the blower is located poorly, where it may pick up coal dust and blow it into the organ. If even a small amount of foreign particles find their way between the reed tongue and the brass tube or reed it beats against, the tone immediately becomes bad, and usually causes a rattle or a silent note altogether. If the note continues to sound, it is considerably off pitch. If the organ can be kept clean and the wind supply also, the amount of trouble that Reed stops cause will be reduced to an absolute minimum.

Obviously there was some hesitation and objection to placing Reed stops in an organ that was going to an out-of-the-way town where a tuner would seldom be available, for, when a set of Reeds does get into bad condition, it is undoubtedly the most villainous sounding stop in the organ. It then becomes quite useless until cleaned and retuned. The modern practice of enclosing the organ in chambers, particularly where the shutters are allowed to close when the wind is off (the usual practice of the Kimball Company), keeps a great amount of floating dust and dirt from settling inside the pipes themselves. Comparatively little trouble is experienced with the Reeds under such conditions, especially when the blower is furnishing clean air to the organ.

We come now to actual construction of Reed pipes. See Figure 24. It should first be pointed out that these pipes have no mouths like Flue pipes and that the pipes themselves play a secondary part in determining the quality of tone obtained. The real speaking part is the metal tongue, usually shaped somewhat like that in a Reed organ or mouth organ. If this tongue is properly adjusted and wind pressure directed against it, it will vibrate in or against an opening cut in a small brass tube called a reed or shallot. The length of the vibrating portion of the tongue is regulated by means of a bent wire which presses the tongue firmly against the reed. The lengthening or shortening of this vibrating part decreases or increases the number of vibrations. Accordingly, the note obtained is proportionately lower or higher in pitch. The shallot and tongue are fixed in a hole in a heavy metal block and the whole affair is enclosed in a sort of pipe foot which is termed a boot. If we now place a pipe in the hole above the reed block and test the tone, we shall find that the note obtained is very much modified in quality. So, according to the length, scale, and shape of the pipe or resonator (as the reed barrel is termed), we may obtain a variety of tones from the same reed. The tone also can be modified by manipulating the tongue.

The block of a Reed pipe into which the shallot and tongue are fitted at the bottom, and the resonator on top, is usually a circular and rather solid mass of pipe metal cast in a mold. Blocks were sometimes made of wood in old work. Especially in the case of high pressure Reeds, this block is of large proportions and considerable weight, to steady the vibrations caused in the lower part of the resonator by the powerful striking of the tongue against the shallot.

Mr. B. G. Austin of the Austin Organ Company has recently conducted a number of experiments in the matter of reducing the vibration of the lower part of the resonator, caused by the violent striking of the tongue against the shallot. This vibration is excessive in large pipes. Mr. Austin has come to the conclusion that a reed block of great weight and size does not accomplish the purpose as well as a heavy weight of lead affixed to the bottom of the resonator (just above where it is secured to the block). This is the point of greatest vibration and needs to be steadied. He has secured some quite remarkable results with the larger pipes by treating them in this manner.

Mr. Austin contends that more builders err in considering that the top of the Reed resonator should be of great weight and density of metal, and believe that weight is more important in the bottom of the resonator where the vibrations are of greater intensity. I believe Mr. Henry Willis is in accord with Mr. Austin in this. Here is a matter that will bear more investigation and study.

The shallot, or reed itself, is a cylindrical tube of brass of varying size, becoming smaller as the pipes become smaller. It is usually slightly conical in shape, being wider at the lower end which is closed by a piece of brass affixed (in almost all Reeds) at right angles to the face of the shallot. In some special classes of Reeds, the bottom of the shallot is set at a very sharp angle to the face of the shallot. Such stops as, for example, the English Horn are so treated. In the front of the shallot an opening is cut for perhaps half its length, though in old style shallots, in order to produce a sufficient volume of tone on low pressure, the entire front was allowed to be open. The former type is called the "closed" shallot, the latter the "open" shallot.

This is perhaps the most important change that has been made in organ tone in the last half century. The new style of shallot was invented by Henry Willis, the illustrious English organ builder. Prior to the advent of Willis, as has been stated, organ Reeds were rather thin, buzzy things with little or no dignity or weight and were most unmusical in quality.

It was common for students to be instructed that a Reed stop should never be used alone but that a Stopped Diapason or other rank of Flue pipes must always be associated with it to improve the tone quality. Henry Willis created an entirely new school of Reed voicing. He was the first to show that Reeds could be made really beautiful, and fit for use, without help from Flue stops. When he wanted power he obtained it by raising the pressure in order that he might still restrain the tone and retain beauty of musical quality as well. He was the first to show that every trace of roughness and rattle could be removed by imparting to a reed tongue exactly the right curve. He weighted the ends of the larger reed tongues, thereby restraining their too emphatic vibrations. He also adopted the practice of using harmonic or double length resonators for the treble notes. This practice secured from these notes a degree of power never before dreamed possible. The upper octaves of the Reeds always suffer from a tendency to become weak. It was Mr. Willis who created the magnificent Chorus Reeds which transform the Swell Organ into a rich, powerful ensemble, which had hitherto been a poor and weak department, entirely overshadowed by the Great Organ. These powerful, live, vibrant Reeds are always thoroughly musical in quality when made by Mr. Willis.

Mr. Wedgwood, in his "Dictionary of Organ Stops," has the following to say as the secret of successful Reed voicing: "It consists in imparting to the tongue such a degree of curvature as will cause it to *roll down* rather than *strike* against the shallot, or maybe against the pnuematic buffer which is commonly supposed to intervene. Should a *flat* spot occur in the reed by reason of an imperfect curve or a speck of dust lodging between the shallot and the tongue, the tone rendered will be harsh and blatant. It is on the precise stoichiometrical curve of the tongue—the distribution of elasticity—that the nature of the tone largely depends.

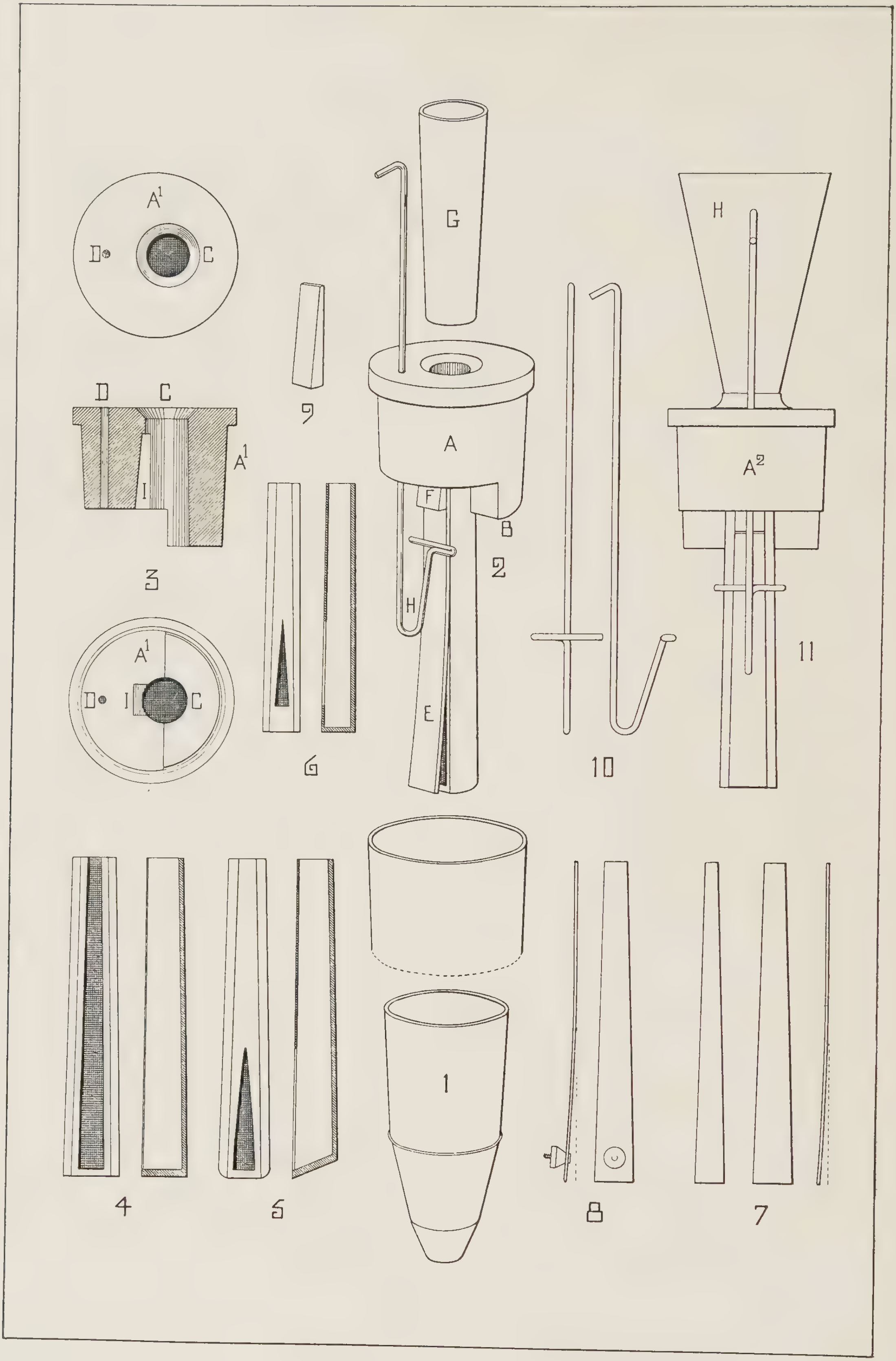


Figure 24.

Portions of Reed Pipes.
(From Audsley, "The Art of Organ Building")

Referring to the drawing on opposite page, Figure 24, 1, is the reed boot, or foot that fits into the block, A, shown in 2, above. 2 also shows the reed tongue, E, wedged against the shallot by wedge, F. Also the tuning wire, H, against the tongue. 3 shows top, sectional and bottom views of the reed block. 4 shows front and side views of the "open" shallot, while 5 and 6 show two forms of the "closed" shallot. It will be noticed that the opening in the shallot shown at 6 starts above the base, forming a pocket at the bottom of the shallot. This type is used for French Horns, with a capped resonator of large scale, which has also a pocket in its top. 7 shows front and side views of a narrow and broad reed tongue. 8 shows front and side views of a reed tongue with a weight attached. 9 is the reed wedge. 10 the tuning wire. 11 a front view of the reed assembly.

"This method of voicing was essentially French in origin. It was developed by M. Cavaille-Coll, whose work reached the zenith of perfection in the voicing of orchestral Solo Reeds. It was Mr. Willis, however, who on these foundations reared the vast edifice of modern Chorus Reed voicing."

It has been pointed out that Mr. Willis was the first to systematically employ small weights screwed on to the end of the tongue, thereby rendering the tongue heavier so that it may be reduced in length. The ill effects of internal and tortional vibration, almost inevitable in the case of long tongues, can thus be avoided.

"Free Reeds" are seldom employed by American organ builders. In these Reeds the tongue passes right through the shallot as in the Harmonium or Reed Organ. Occasionally Clarinets are made with "Free Reeds." The voicer has obviously little control over the tongue, and therefore the quality of tone is mainly determined by the shape of the tube or resonator. It also happens that all "Free Reeds" bear a strong resemblance to each other, and also to the Harmonium tone. The characteristic of "Free Reeds" is the excessive development of harmonics. They were formerly employed very largely in Germany but are seldom manufactured at present.

Another matter that should be mentioned is the practice of the German builders of leathering the face of the shallots where the tongue strikes. This practice has extended to America by means of many of the German pipe makers coming to this country and continuing to employ the art they learned in Germany.

The facts are that typical small church organs manufactured by the smaller builders in America are likely to have more German characteristics of tone than English or American, because in many cases these small builders purchase their pipes from various houses that supply pipes for the trade, several of which are headed by men who have learned the art in Germany. The scales and practices generally employed in Germany have been transferred to this country and have had a very considerable influence on pipe construction and tone in America.

Shallots are faced with leather to secure smoothness of tone. To do so is merely a makeshift means instead of the scientific, though

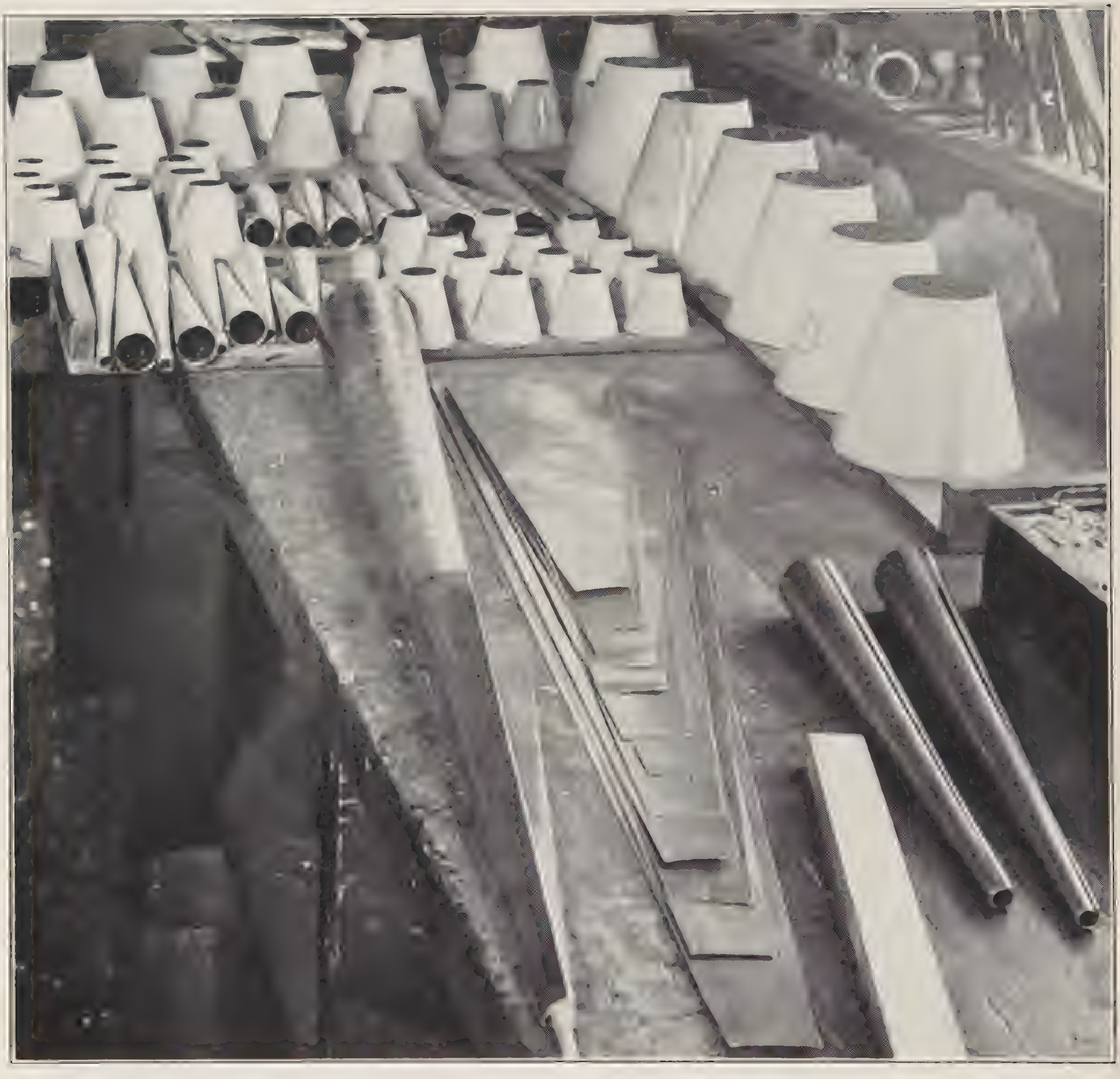


Figure 25.

Reed Pipe Making. The bodies of the reed pipes are cut from patterns, as in making Metal pipes, and shaped around a mandrel with the proper degree of taper. Reed pipes are nearly always conical in form. The reed pipe body that is being formed on the mandrel at the left has its top made of pipe metal, while the lower portion is made of zinc. The flat sheets are made to assume the proper curve by pounding with a flat board on the mandrel. The large white conical shaped parts shown near the top of the photograph will be soldered on to the tops of the pipe bodies to make them flare. This is a French Trumpet, made in the Moller factory.

arduous, process of securing smoothness by properly curving the tongue. Particularly is this true of the bass octave of Reed stops where the curve must be absolutely right to secure a smooth tone (without leathering being resorted to).

The best Reed voicers I know in this country dislike and look with disdain on this practice and never resort to it themselves. Such voicers consider it a form of cheating at the game of Reed voicing.

There is this to be said in favor of leathering shallots, particularly when padded with heavy leather in the manner that is systematically employed by the Gottfried Company of Erie, Pa. A small particle of dirt between the tongue and the shallot will not cause the unpleasant rattle that is bound to occur where the shallot is not leathered. With these leathered shallots the Gottfried Company has succeeded in producing some excellent examples of Clarinets, French Horns, and other orchestral Reeds. When leathering is employed for the Tuba or other Chorus Reed tone, the results are not satisfactory to the educated and discerning ear.

No one has condemned the practice of leathered shallots more strongly than the late Mr. Willis, as well as the present Mr. Willis. They have both conclusively demonstrated that it is not essential to smoothness of tone. The smoothest Reed tone yet produced excepting the French Horn, is the Hope-Jones Tuba Sonora, which does not have leathered shallots. Hope-Jones was too much of an idealist to make use of the subterfuge.

Without question, it is more correct, on scientific grounds, to secure the proper curve of the tongue and thus a smooth tone, than it is to merely pad the surface so that an indifferently curved tongue will suffice. I do not blame the commercial pipe makers for leathering their shallots. When pipes must be sold competitively, such practices are quite justifiable.

A device that is placed at the bottom part of the very large reed tongues (such as the 32 foot octave of the Pedal Bombarde) is a pneumatic starter and stopper. When this is not provided, the tongues are likely to be slow in starting and the note will continue to vibrate for some time after the wind has been cut off. This has been sometimes termed the "death rattle."

The Skinner Organ Company now employs such starters on all of their 32 foot octaves of Reed pipes with excellent results. When Mr. Skinner was chided once by an organist because his 32 foot Reeds were slow in starting to speak, he said, "Yes, but think how long they hang on after the note is released."

The boots of all the 32 foot Reeds which this builder now makes

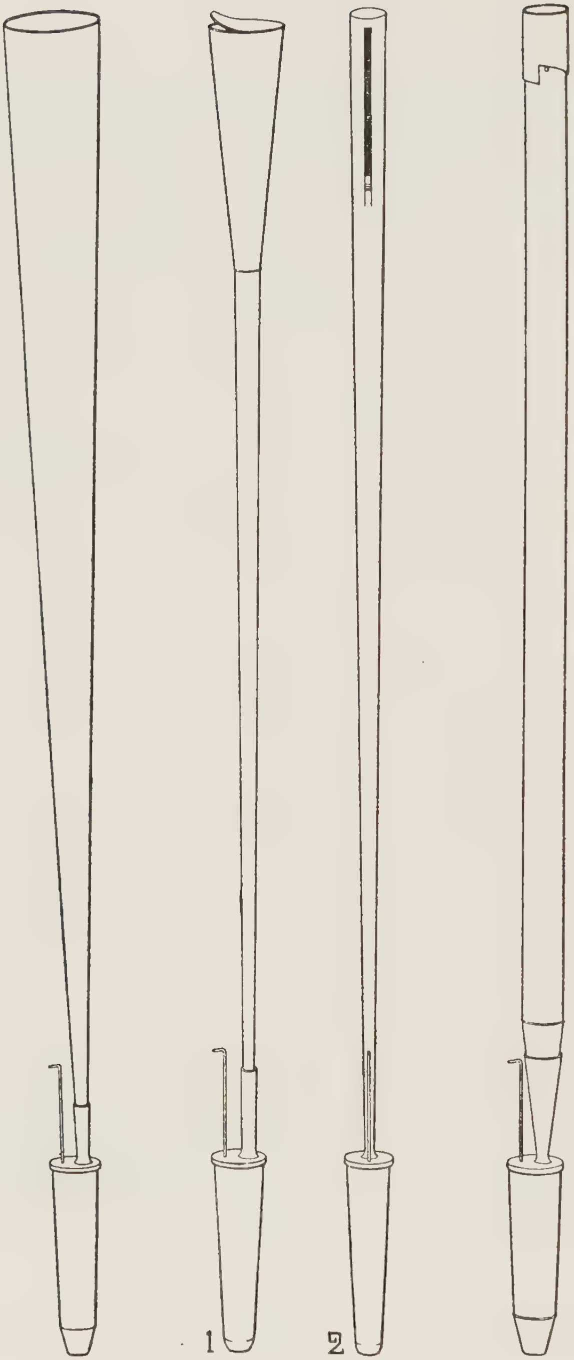


Figure 26.

At the left, the general shape of the reed barrel or resonator employed in obtaining Chorus Reed tone. 1 is the ordinary or organ Oboe while 2 is the Orchestral Oboe or more imitative stop. On the right is the Clarinet.

(From Audsley, "The Art of Organ Building")

have an airtight plate of glass secured on the front side of the boot, which enables the tuner to examine the vibrating tongue and determine exactly what is happening (a very clever device, and practical).

Probably the chief factors controlling successful Reed voicing are the following: 1. correct construction of the pipe, 2. correct curvature of the reed tongue, 3. correct use of wind pressures, 4. correct tuning in relation to the proportions of the reed and tube or resonator. This last is a most important point and is frequently misunderstood.

Taking up the construction of the parts of the pipe, we have learned that the tube or resonating body varies in shape in accordance with the type of Reed tone required. In the Chorus Reeds, that is Trumpets, Trombas, Cornopeans, Tubas, etc., the tube is of inverted conical shape. The diameter at the top of the pipe at 8 foot C varies from a little over four inches to as much as five and one-half inches in accordance with the type of tone required.

The Reeds that imitate the orchestral voices have a narrower tube, and usually shorter than that of the Chorus Reed tubes. An exception is the French Horn. This stop is successfully made with a pocket in the bottom of the shallot produced by cutting the opening some distance up. The barrel is capped on top, with a tuner near the top for regulating. Each imitative Reed has its own peculiar shape, a number of which are shown in Figure 27.

The tip of all reed tubes, that is the part which joins the block, should be narrow. To make the opening at this point too wide is an error made by the earlier European and American organ builders. The former practice did not permit of adequately controlling the tone at the point of juncture, between the block and tube. Mr. Hunt states, "To constrict this opening forms a striking confirmation of the *bouche fermee* method of teaching singing in which the student is instructed to practice scales on "M-Woo-ah" in order to acquire pure tone. The human voice being a reed controlled in a similar manner to that of the organ reed, it does not require much imaginative power to discern the parallelism here evident."

The length of the tube is a matter of great importance. If the tube is too long, a sort of throttled or choked note results and the tone is said to be too close. If, on the other hand, the tube is too short, the tone is coarse and said to be too "free." Exact proportion of the length of tube to the length of reed tongue permitted to vibrate is a matter of the greatest importance therefore. As a matter of practice the tubes are usually left a trifle too long and are then adjusted to a nicety so that the pipe will speak its natural "free" note without being too close nor harsh.

The tongues and shallots have already been described. The chief difficulty in the treatment of the tongue is encountered in giving it the proper curvature. This is the most difficult department of Reed voicing. The quality of a curve must be adjusted so as to enable the tongue to roll down the face of the shallot during the process of striking. This is usually tested by holding the shallot with the tongue in position in front of a light so that the light shines between the tongue and the shallot, the while slowly depressing the tongue with one's forefinger. The darkness caused by the exclusion of light is seen to travel in an even gradation along the intervening space until, with the contact of the head or base of the tongue with the end of the shallot, all light is completely excluded. The quantity of curve varies with the thickness of the tongue and the pressure of the wind employed.

If the tongue is not sufficiently curved or is too thin and pliable, the force of the wind will drive it too sharply against the shallot. Therefore, the thicker the tongue and the lower the pressure, the less the curvature required, also the less the quantity of tone obtained from the pipe. The smaller tongues are nearly always curved by hand by the Reed voicer who becomes very expert in knowing just what motions to make to create the proper curvature. An expert voicer can frequently secure a correct curve both in regard to quantity and quality after the first trial. The larger tongues are usually curved in a curving machine.

The tongues are curved by placing them flat on a block of polished steel with the top or narrow end of the tongue clamped securely down, leaving the broad end free. A burnishing tool is used, which is merely a cylindrical piece of steel. This is drawn along the surface of the tongue with a gradual increase of pressure which reaches its greatest amount at the head of the tongue. This process is repeated if necessary until the curvature is sufficiently pronounced. The curving machine performs precisely the same operation, the quality and degree of the curve being regulated by a cam. It must be again remarked that the curvature of the tongue has a great influence upon the speech and tone of a Reed pipe.

Assuming that the curve is correct, in respect to its quality, it may yet be too pronounced or insufficient. Too great a curve makes the speech slow while not sufficient curve causes the speech to be too "free" and quick. The precise amount of curvature has to be determined by the voicer when engaged in the work of final finishing. Heavy wind pressures are of enormous advantage to the Reed voicer.

Mr. Hunt states, "The length of the tongue is determined by the following factors that are dependent upon each other: 1. minimum thickness of tongue; 2. the maximum degree of weighting; 3. the length and

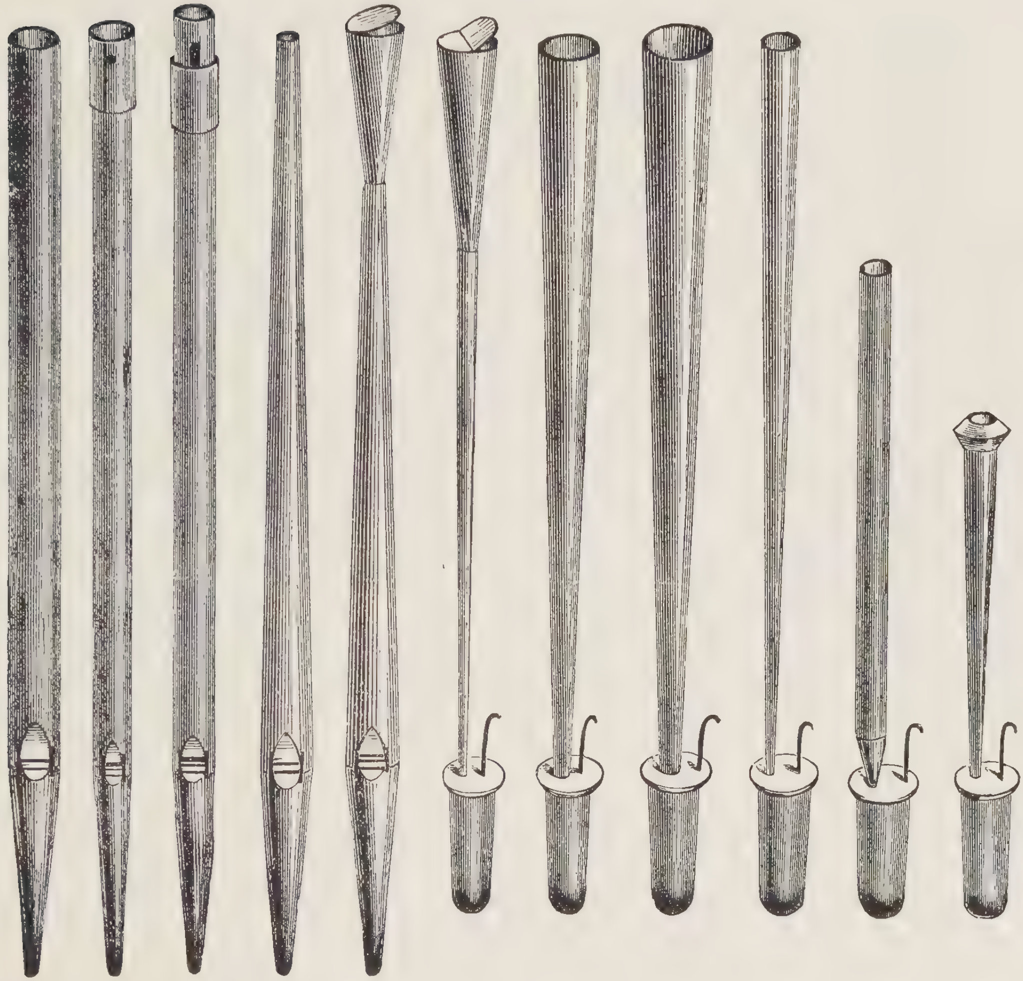


Figure 27.

Examples of various types of pipes all of which will sound the same pitch. From left to right they are as follows: Open Diapason, Salicional Diapason, Dulciana, Gemshorn, Bell Gamba, Oboe, Trumpet, Tuba, Cornopean, Clarinet and Vox Humana. (The Vox Humana is an old form) (From Mark Wicks, "Organ Building for Amateurs").

scale of the tube; 4. the wind pressure available. A factor which is frequently misunderstood by some Reed voicers is that the length of the resonating tube must bear some definite relation to the natural pitch of the vibrating tongue, if the tone of the Reed is to be satisfactory. Sharpening the pitch of the Reed makes the tone softer and the speech slower, while flattening the pitch makes the tone louder and 'freer' and the speech quicker. If the tube is too long, the tongue has to be shortened to pitch and the tone is too 'close'. If the tube is too short, the tongue has to be lengthened to pitch and the tongue is too 'free'. Therefore, the tube must be so adjusted as to be in proper proportion to the pitch of the reed itself." In the case of most American reed resonators, the final adjustment is done on the tuning slot. In the case of most English Reeds, the tubes themselves are actually cut to the proper length.

The latter is an ideal arrangement where the temperature remains approximately uniform but where the organ has to be tuned at widely different temperatures, such as the organs in most American churches, between winter and summer heat, the regulation of the power of the Reeds would be completely upset if there were no way of tuning the Reeds except on the tongue, that is by means of the tuning wires.

We have already noted that one of the peculiarities of Chorus Reeds is their tendency to grow weaker in the upper portions of the scale. This is nearly always compensated for in the best work by making the upper 12, or frequently the upper 24 Reeds, harmonic. That is, making the resonators of double normal speaking length, and in this manner a tone of greater power and quality may be obtained from the upper notes. Even with this expedient, it is difficult to obtain as much power from the top as from the middle and lower octaves and in some instances of very powerful Tuba stops, the resonators have been made three times their normal speaking length and are therefore triple harmonic. An instance of two large Tubas so treated is the Atlantic City High School organ. These Tubas were voiced in the Midmer-Losh factory and they are fine specimens of this type of tone, with great power.

Usually with Chorus Reeds, many builders leave off the Reed pipes at the 49th note for an 8 foot stop and continue the top octave or second top octave (if a 73 note stop) with Flue pipes. Some of our builders continue the Chorus Reed tone up to the 54th pipe on an 8 foot stop. In any event, all the solo or imitative orchestral voices should be continued in Reeds to at least the 54th pipe on an 8 foot stop, in order to avoid the break in tone which is inevitable between Reed pipes and even the most closely matched Flue pipes.

This is a point that many of our builders overlook. Of course, these extremely small Reed pipes are difficult to make and voice but the additional trouble is worth while, certainly for solo stops.

DIAPHONES

The third distinct class of organ tone is the Diaphone which is neither Flue nor Reed tone, but a special type of tone invented by Hope-Jones in 1894. This tone was considered of great importance and value for several years after its invention and some organists anticipated that the organ of the future would be built upon the Diaphone as a foundation. They believed the Diaphone gave the greatest and most dignified Diapason possible. A very good example of the Diaphone was built by Hope-Jones in the instrument in Ocean Grove, New Jersey.

This tone is confined chiefly to the pedal organ, where its weight and volume are greater than it is possible to produce by either Reed or Flue pipes. Figure 28 shows the type of Diaphone that is now most generally used. It is the most practical of the various forms that Hope-Jones invented. This is the one used in the Hope-Jones organ in St. Paul's Cathedral, Buffalo. To quote from Mr. Hope-Jones' description, its action is as follows: "Upon pressing a key, wind is admitted into the box, B, pressing upon the disc valve, V, it causes it to close against its seat, against the counter-action of the spring, S. This closing, however, does not take place until a pulse of air has passed into the foot of the pipe, P, thereby originating a sound wave, producing a partial vacuum, which in due turn liberates the valve V and allows the spring S to move the valve off its seat, and allows another pulse of air to enter the pipe, P. By this means the valve V is kept in rapid vibration and a powerful note is produced from the pipe P."

One of the peculiarities of the Diaphone is that the pitch remains practically constant with a considerable variation in wind pressure. By increasing the wind pressure, the violence of the vibrations of the valve may be increased and the tone can be made louder but the pitch is not greatly altered. Flue or Reed pipes are affected to a much greater extent by changes in pressure than the Diaphone.

The form of the pipe or resonator affects the quality of tone somewhat similarly to such changes of form in a Reed pipe. It is possible to imitate Flue or Reed tone and even String tone with a Diaphone. Generally the Diaphones that have come under my observation have produced a tone almost wholly foundational with very small harmonic development, and therefore they form an excellent foundation for a pedal organ, particularly where great power is required. Twenty-five inch pressure may be easily and profitably employed on a pedal Diaphone

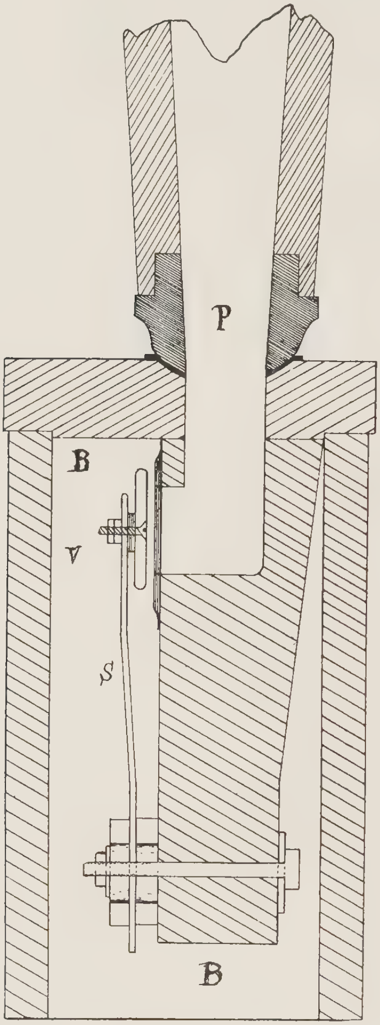


Figure 28.

The most successful form of the Hope-Jones Diaphone, described in the text (Miller, "Recent Revolution in Organ Building").

that would be impossible on any form of pedal Flue pipe, except double languid.

The tone has the advantage of being extraordinarily prompt, particularly in the case of low notes, something which is very difficult if not impossible with Flue pipes. Large Flue pipes require a certain amount of time to generate the note. Some builders and organists dislike the tone of the Diaphone. On the other hand, the Kimball, the Wurlitzer and the Austin Organ Companies have frequently made use of the Diaphone with very satisfactory results. The latter company made a modified Diaphone, which they called a Magnaton, for many of their large organs where a powerful 32 foot foundation was required.

A pedal 16 foot Diaphone with metal resonators, that may be mitered as easily as Reed resonators, requires much less space than a 16 foot wood pedal Diapason. It will produce a bigger and more powerful tone more promptly than a pedal Diapason. In cases where space is limited, I can see no objection to such a stop. In the organ in my home, I have a pedal Diaphone on the moderate pressure for a Diaphone of seven inches, in place of the usual pedal Diapason. This is eminently satisfactory and does not require more than half the space. Where space is not at a premium and where volume is not required, I agree with those who hold that Diaphones are better confined to theater or residence organs, and not installed in church organs. They are particularly valuable for a theater organ where the pedal part is normally played staccato, because of their rapid speech. The ordinary pedal Diapason would scarcely be able to generate a tone before it would be cut off by the usual theater organist's style of pedaling.

It is always valuable to remember Jack Spratt and his wife—so in ideas *re* organ tone. What holds good in a cathedral does not in a theater. There are uses for many types of pipes. The Diaphone has some undoubted advantages over any form of Flue pipes. It also has some peculiarities of tone quality that are not ideal for church use.

CONTRIBUTIONS TO THE TONE OF THE AMERICAN ORGAN

It would be incomplete to close the chapter on the Sound Producing Portions of the Organ, without some reference to the contributions of several American builders, and Mr. Ernest M. Skinner in particular, to the tone of the American organ. Many American organ builders have made improvements and discoveries in organ tone but probably none of them has been more interested nor has done as much along these lines as Mr. Skinner. It is interesting to note that his interest was first aroused in Reed tone especially when he visited England many years ago.

The marvelous Reeds voiced by "Father" Willis served as an inspiration. Until this time no such Reeds existed in the American organ.

The "profound impression" made upon Mr. Skinner by the Willis 16′ low C Trombone has endured. The first Skinner replica was made in the Hutchings factory immediately upon his return and the many fine Reeds in which Mr. Skinner takes such pride are partly a result. There is the French Horn, the English Horn, the Orchestral Oboe. Of another family is the Erzähler with its curious name. It is interesting to learn how the name was applied to this stop. Mr. Skinner had the pipes on the voicing machine and was testing their tone. It struck him that his new pipes were "garrulous with a chatty sort of friendliness." He turned to a German employee—"Do you know any word that means talkative, garrulous?" "Erzähler." Erzähler was short enough to go on a stop-knob, it was euphonious; what more could be asked?

The following is quoted from the "American Organist:"

"Every great achievement of man is the product not of hands but of the imagination. I want Mr. Skinner to tell how the ever-present Skinner French Horn came into being.

" 'What I have done in creating the Skinner Organ is due almost wholly to a love of music, plus a mediocre inventive faculty, plus an unbounded belief in the orchestra and so under the stimulus of some great orchestral or operatic work I have worked out all the orchestral colors and have included them in the Skinner Organs. When the organ was planned for Williams College, Mr. Salter insisted on a French Horn and so one was written into the specifications. Before that time Richard Strauss' Salome was given by the Manhattan Opera Company and I had heard eight French Horns in unison in the Salome Dance and was from that time on determined that the French Horn should be added to the voices of the organ if I could ever get the opportunity to work it out.

" 'The opportunity came and after much research the French Horn took its place in the Skinner Organ.

" 'I had a better French Horn than I really expected for the tone was not only there but the so-called bubble was also present.

" 'The reception of the orchestral colors by the various organists has been most curious and follows as definite a law as the law of probabilities in an insurance schedule.

" 'Those who are interested in music for music's sake, the orchestra, opera, piano and any good music have welcomed these voices. The Classicist, the Ritualist and the Purist have fought and disapproved them. One writer says they are neither "fish, flesh nor fowl," but we kept on making them and now no organ is considered complete without them.' "

Among the registers that Mr. Skinner claims were especially designed by him and are peculiarly characteristic of his work are the following, as taken from the list furnished by Mr. Skinner himself. In each case the organ is mentioned in which the register was first used. All are 8′ unless otherwise noted:

ERZÄHLER—Christ Church, Hartford, Conn.
ORCHESTRAL OBOE—Tompkins Avenue Congregational Church, Brooklyn, N. Y.
ENGLISH HORN (8′ and 16′)—City College, New York.
FRENCH HORN—Williams College.
KLEINE ERZÄHLER—Fourth Presbyterian, Chicago.
GROSS GEDECKT—Second Congregational, Holyoke, Mass.
CORNO DI BASSETTO—Williams College.
TUBA MIRABILIS—St. John Cathedral, New York.
FRENCH TRUMPET—St. John Cathedral, New York.
ORCHESTRAL BASSOON (16′)—Skinner Studio, Boston.
GAMBA CELESTE—St. John Cathedral, New York.
BOMBARDE (32′)—City College, New York.
VIOLONE (32′)—St. John Cathedral, New York.
SUB BASS (32′)—St. Thomas, New York.
CONTRA BASSOON (32′)—Princeton University.

We have already mentioned some of the original work of Mr. William E. Haskell of the Estey Organ Company, with his short length pipes. In addition, he developed a family of imitative Reed voices from labial pipes which give very fair reproductions of Solo Reed tone. The Reedless Oboe, the Reedless Clarinet and the Reedless Saxophone are three of the most successful stops of this class. They are particularly valuable when a small organ is placed in a church a long distance from a tuner, as these stops will stay in tune as well as other labial pipes.

A voicer of unusual capabilities is Mr. George Michel of the W. W. Kimball Company. He has developed some Orchestral Reed tone, particularly English Horns, French Horns and Saxophones, along somewhat different lines from Mr. Skinner, but of excellent quality. The Chorus Reeds, and Strings that he has produced are also very superior.

Many other builders have specialized in the production of certain voices, but I believe the examples specifically noted here are perhaps the most outstanding and original.

PIPES OF EXTRAORDINARY POWER ON HIGH PRESSURE WIND

REFERENCE has already been made to the marvelous Reeds that "Father" Willis developed and consistently placed in his important organs. Perhaps his two finest examples of powerful

Tubas are those in St. George's Hall, Liverpool, and St. Paul's Cathedral, London. When it is considered that the former Tubas were made in 1855, and that "Father" Willis* was enabled to get organ wind pressure of more than twenty inches, and action to work on this pressure as early as this, when practically all other builders were using pressure not higher than three inches, we can perceive the tremendous advance that Willis created in organ building, both mechanically and tonally.

The Tubas he built for the two examples we have mentioned are the finest that exist in the world today so far as I know. "Father" Willis was nearly half a century ahead of the other builders in producing this type of tone.

In addition to producing the modern type of Reed tone with the closed shallots which has been described for Chorus Reeds, on moderately high pressure (that is, pressure between seven and ten inches), he produced these gorgeous specimens of high pressure Reed voicing of such extraordinary grandeur. Other builders have been deeply impressed with this work and have produced Chorus Reeds and high pressure Tubas along similar lines.

One of "Father" Willis' sons, Mr. Vincent Willis, proceeded along the lines of creating greater power from the Diapasons though his original

---

*The original Henry Willis lived 1821-1901. He was the builder of many famous English organs and made many improvements in organs, both tonally and mechanically. Two sons, Henry Willis II, and Vincent Willis, were organ builders, the former succeeding to the "Father" Willis business. The firm is continued by Henry Willis, III, the son of Henry Willis, II. The present Henry Willis is maintaining the great traditions of the family name in such instruments as the Liverpool Cathedral organ, the largest organ in England. The present Henry Vincent Willis, is another grandson of "Father" Willis and cousin to the present Henry Willis. He is known as "Harry" Willis, and is now engaged in what he calls "pioneer" work on the Atlantic City Auditorium organ, being built by Midmer-Losh. "Harry's" father, Vincent Willis, died in 1928.

I learn from a paper, kindly loaned me by the present "Harry" Willis, that his father had much to do with the voicing of the high pressure Reeds in many of the "Father" Willis organs. Also that J. C. Bishop was the inventor of the closed shallot. George Willis, brother of "Father" Willis learned of high pressure reed voicing from Bishop. It appears that George Willis did much of the high pressure Reed voicing usually attributed to "Father" Willis, himself.

These facts are not important, except to create the impression that the whole Willis family were skilled organ builders, brothers, sons and grandsons. They all helped to establish the Willis family name as standing for advances in organ building in both mechanical and tonal matters. It is unfair to think of "Father" Willis and the present Henry Willis as the *only* organ builders of that name who have added lustre to the Willis tradition.

It should not be supposed from our frequent allusion to the Willis family in these pages that they are unquestionably the greatest English organ builders. There are probably more divergent opinions about this in England, than there are here as to who is America's leading organ builder. The Willis firm and John Compton are mentioned specifically on numerous occasions in the course of this work because of the elements of originality and leadership along many lines of organ building that are evident in the work of these two.

Mention should be made of the firm of Harrison & Harrison, whose work stands very high in England. Also the firm of Hill, Norman and Beard have done much important work which should not be overlooked, to mention only two other leading English builders.

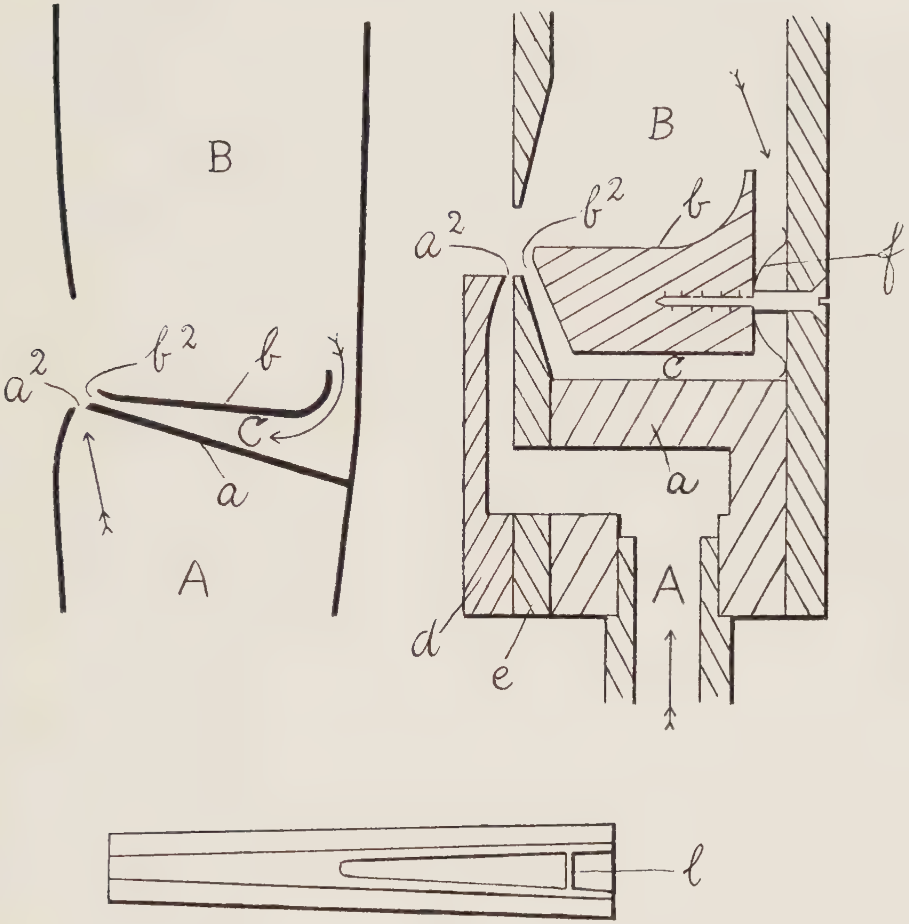


Figure 29.

Upper left, cross section of a Double languid Diapason. Upper right, sectional view of a double languid wood pipe. Lower left, front of shallot used on 100″ pressure reeds. The bottom piece of the shallot is not soldered at the base, as is usual, but further up the tube. This leaves the shallot open for a distance, and allows the tongue to travel a greater amount before covering or uncovering the effective opening of the shallot. (From Vincent Willis' Patent Drawings).

invention of the so-called double languid Diapason was not at first on high pressure. This type of construction has been used very extensively in the organ now being built in the Atlantic City Auditorium, not only for Diapasons but for Flutes and Strings as well. Pressure up to forty inches has been used on some of the double languid pipes in this installation with remarkable results both as to power and quality of tone.

The present Mr. Henry Willis (the grandson of "Father" Willis), has made use of double languid Diapasons with great effect both in his Westminster Catholic Cathedral organ in London and his Liverpool Cathedral organ.

When another grandson of "Father" Willis, Vincent Willis, who is a cousin of the present Henry Willis, was working with the Welte Organ Company, he produced a double languid Diapason for the Wanamaker Store in Philadelphia. He is now in charge of the work on the double languid stops for the Atlantic City Auditorium as well as the exceedingly high pressure Reeds. Two stops of one hundred inch pressure are contemplated for this organ and though all the details have not been practically worked out, Mr. Willis has actually constructed sample pipes that will operate on this pressure of wind.

Mr. Vincent Willis has kindly furnished me with a copy of his father's patent which is dated November 30, 1908 and fully describes the principles underlying the double languid pipes. By referring to Figure 29 it will be seen that the principal languid is depressed toward the back of the pipe, and a secondary languid is introduced a little above the point that the ordinary languid would be placed in the usual form of pipe.

This secondary languid does not extend all the way to the back of the pipe but is turned up a short distance from the back, creating in effect an internal beard.

Mr. Vincent Willis, in his patent specifications, states: "The invention is an attempt to enable the organ builder to obtain, when necessary, Diapason or other tones found in the organ in greater power of volume than heretofore, and without the deterioration or change in quality of tone which attends and therefore limits the increase of volume of sound by ordinary methods. But the invention is also useful when a higher development of overtones is sought without an increase of tonal output.

"Of two similarly voiced 'Flue' pipes, of the Diapason type for instance, speaking the same note and of appropriate but different scales, the trained ear will, on the question of quality of tone only, prefer the pipe of smaller scale, because it is naturally richer in overtones. By the application of this invention to the larger scale pipe, a development of overtones similar to or, if desired, higher than that found in the smaller scale pipe can be obtained in greater volume from the larger scale pipe; in other words, the control of scale over quality of tone has been reduced.

"The speaking lengths of two such pipes differ, the smaller scale pipe being the longer of the two. This difference in length would appear to be due to the greater velocity of the air in the smaller scale pipe. In Reed pipes, however, this condition is reversed, the large scale pipe being the longer of the two."

The operation of the double languid pipe is as follows: "If the upper or false languid be perforated, air will be drawn from the body of the pipe, with a like result as to the volume of the stream of air from the flue of the pipe. . . . The stream is first deflected outwardly, but the indraught at the upper part of the mouth is now increased, the net result being an inward deflection of the stream of air. By this method, increased tonal output with the desired development of overtones can be obtained from any class of metal flue pipe.

"The principle of this invention is equally applicable to Flue pipes made of wood, or to String tone. In the case of String tone, pipes fitted with an external roller or beard have been built for eighty or ninety years. The tonal output of the upper part of stops of this class has usually to be somewhat restricted because of defective utterance and tone of certain pipes. These are generally found in two or three groups, of two or three successive notes, which cannot be brought up to the standard of the others, and such pipes have to be 'faked' rather than voiced. All such difficulties are overcome by the use of the double languid.

"Referring again to Figure 29, A is the foot and B the body of a Diapason pipe constructed of metal; a is the languid proper, b, the false languid, which is turned up at the back of the pipe in order to establish communication between the air in the cavity C and that in the body of the pipe B, and also to avoid an angle of inert air; a^2 is the flue of the pipe; b^2 the opening between the two languids, or the false flue.

"The stream of air from the flue of the pipe a^2 rushing past the false flue b^2 draws in air from the body of the pipe B, as shown by the arrow. The reinforced stream of air impinges on the lip of the pipe, none, of course, passing up the pipe; but greater variations of density in the air of the body of the pipe are obtained than heretofore and consequently there is a higher development of overtones."

The construction of the double languid pipes being used at Atlantic City, which the Midmer-Losh Company are making and which Mr. Vincent Willis is voicing, has been somewhat simplified. The pipes are first made just as ordinary Diapason or String pipes and then they are sawed diagonally across, a short distance above the regular languid, and a second languid of the type shown in our drawing is applied and the pipe soldered together again. This seems to produce as good or better results than Mr. Willis' original construction, and is somewhat more economical to employ on a large scale.

The extraordinary results obtained from these pipes at Atlantic City would seem to justifiy their use where great power is required, without sacrificing essential quality. The effect of the double languid on the speech of the pipes is to permit them to be blown much harder without causing them to sound their harmonics, than would be possible without such treatment. This permits of vastly increased power from a given cut-up of the upper lip. If any such pressure or winding were attempted from ordinary pipes, the upper lip would have to be cut so high (in order to prevent overblowing) that the resulting tone would be nothing more than a large Flute with practically no harmonic development, or, in other words, simply a high pressure Phonon Diapason. The double languid construction produces Schulze Diapason quality with enormously greater power than was ever conceived to be possible on the pressure which Schulze employed.

CONSTRUCTION OF HIGH PRESSURE REEDS

Figure 29 also shows the shallot for a high pressure Reed invented by Mr. Vincent Willis. It will be observed that the head of the shallot has been removed from its usual position, and without altering the shallot itself, the head has been fitted in a position further up the shallot at a distance from its usual position not exceeding 1/6 or 1/5 the tuning length of the tongue. With such placing a longer closure, or opening, is insured together with a reduced influx of air, a longer period between the influxes and consequently an equal development of ground tone and overtones from the vibrating tongue. This is the type of shallot that the present Mr. Henry Willis has scaled out and actually constructed for the 100 inch pressure Tubas at Atlantic City. This invention when attached to Reed pipes performs the same purpose as does the double languid with regard to Flue pipes, that is, it permits of a higher development of the overtones. The purpose is to limit the inrush of compressed air into the shallot by reducing the pressure thereon, thereby preventing choking, and consequently insures a better utilization of the energy of the compressed air on the tongue.

As this 100 inch pressure Tuba has not been completed, it is impossible to say at present whether or not it is worth the extra cost of the blowing mechanism. It is very doubtful in my mind that any finer large Tubas can be produced by 100 inches of wind than "Father" Willis secured on 20 inches. My own reaction to the present Henry Willis' Tubas in the Liverpool Cathedral organ is that the 30 inch Tubas are to be preferred in quality to the 50 inch Tubas. In other words, it appears unlikely that pressures much in excess of 30 inches are of any great value when applied to organ pipes of any description.

These experiments are, of course, highly interesting from the standpoint of the tonal enthusiast, and may lead to something of real value. However, the difficulty of raising wind pressure beyond 30 inches and the consequent strain on reservoirs and actions when such pressure is produced, makes it seem extremely unlikely that such excessive pressures will ever be generally employed in even very large organs. The Chorus Reeds that have been finished in the Atlantic City organ on pressures between 25 and 30 inches are magnificient in their effect, and it seems that little more need be sought with regard to either volume or tone quality.

Mr. R. P. Elliot, when in charge of the Welte Organ Company factory in New York, reached the same conclusion with regard to the experiments with 100 inch Tubas that were conducted there a few years ago. These experiments were suggested by Mr. Charles M. Courboin, when he was head of the Wanamaker organ shop. However, Senator Richards may find that such pressures are really worth while in a building of such extraordinary proportions as the Atlantic City Auditorium.

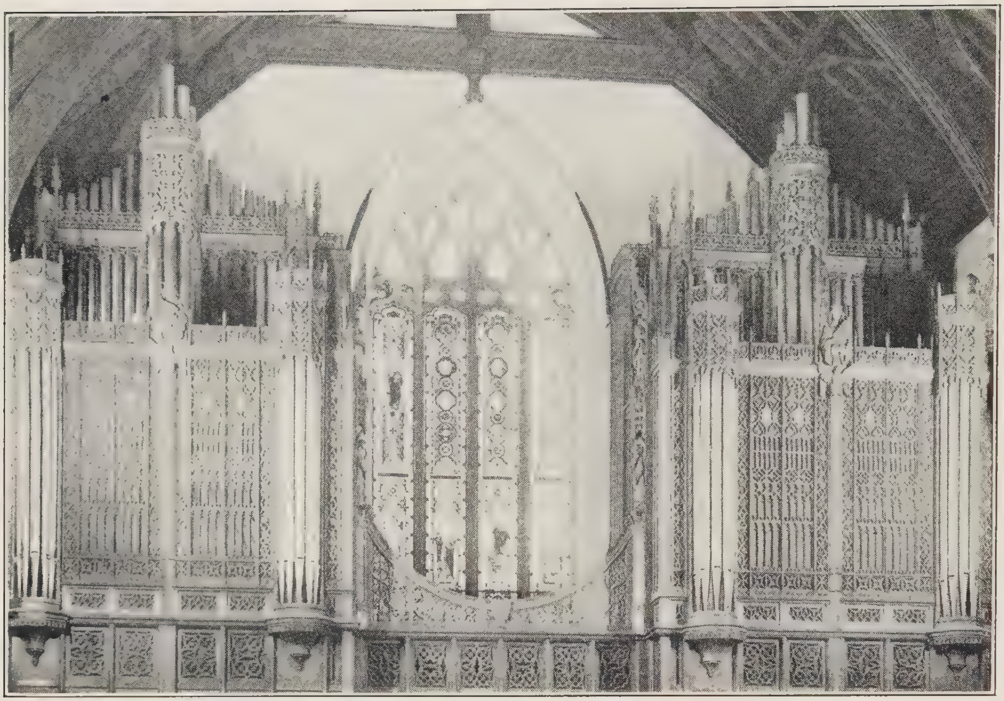


Plate V.

The casework of the Gallery organ in Emmanuel Church, Boston. Casavant Frères are the builders of the organ. This form of casework is an unusually artistic combination of display pipes and grilles.

CHAPTER 4.

PIPE SCALES

IN our chapter on the Construction of Flue Pipes, we made frequent allusions to the scale of the pipes. Every organ builder, before actually starting to construct pipes, lays out a scale from which the measure of the various diameters of the cylindrical pipes for each note may be obtained. The size of the scales ordinarily varies with each stop in the organ. It is not desirable for two sets of pipes to have exactly the same scale or diameter unless in a very large organ.

The English system of measuring pipe scales is simply to state the diameter of the CC pipe in inches.

Obviously when the exact diameter of the CC pipe is known definitely in inches there can be no chance for mistake or argument and when it is known at what point the diameter is half of this, whether at the 16th, 17th or 18th pipe above, almost everything is known that can be given about the diameter of the pipes of that particular register.

A great many years ago in America a different system of designating pipe scales was devised which is almost universally used by the various builders, though the same numbers do not necessarily indicate precisely the same thing. Number 1 on this scale represents a pipe one meter in diameter, and this scale proceeded upward, halving its diameter on the 16th pipe, so that a pipe of scale 16 would be ½ meter in diameter and a pipe of scale 32 would be ¼ meter or slightly less than 10 inches in diameter. A 38 scale pipe, therefore, would be about 8″ in diameter. The 40 scale pipe about 7⅜″ in diameter. A 42 scale pipe about 6¾″ in diameter. Therefore, a 58 scale String-tone pipe, which is 16 pipes above a 42 scale Diapason, would be half the diameter of the 42 scale pipe, or a 3⅜″ diameter for the CC pipe.

These dimensions are accurate within about 1/16″ as there seems to be no absolute comparison. Each builder has developed his own scales, and quantities of them for the various pipes they manufacture. It is quite common to have the Diapason scale halved on the 16th pipe, but frequently it is not halved till the 17th. String-tone ranks are usually made so that they do not halve until the 19th pipe, for they grow smaller more slowly than Diapason pipes as they proceed upward in the scale.

It will appear from this that there is approximately 5/8″ difference between the diameters of the CC pipe or 42 scale and 40 scale Diapasons and slightly more than this between 40 and 38 scales.

The trade pipe-makers, particularly in this country, always refer

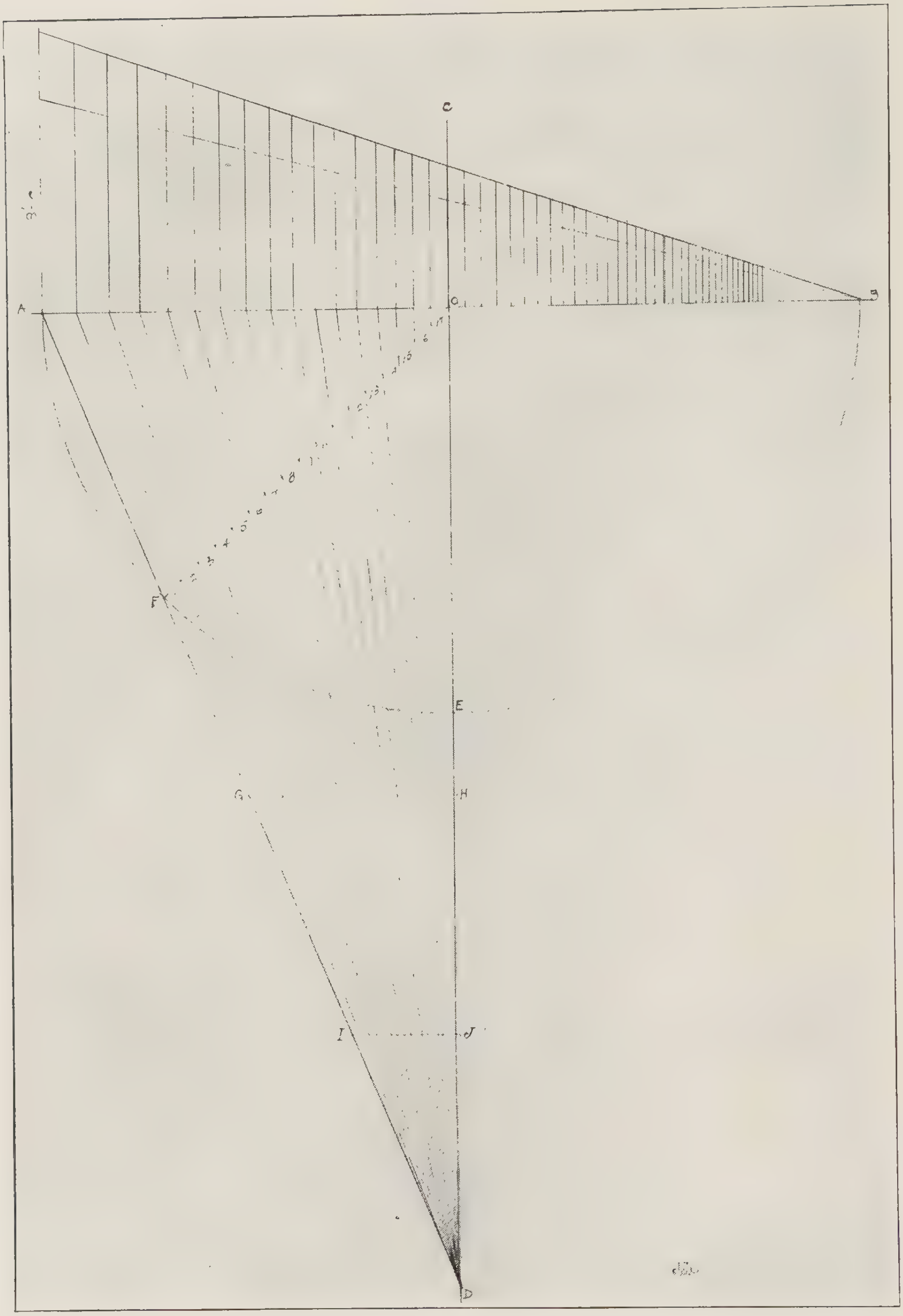


Figure 30.

A method of drawing a pipe scale devised by Joseph J. Carruthers. To lay out this scale, proceed as follows: Line AB is drawn, then at right angles line CD. From point O, a semicircle AEB is drawn to any radius. OF bisects the angle AOE. OF is then divided into as many equal parts as it is desired to make the scale become one half. Then the line AF is drawn and extended to cut the line CD. From D lines are drawn through dividing points on line OF, until these lines cut line AB. From line AB, vertical lines are drawn upwards, at points of intersection. Then from point B a line is drawn to the desired scale at 8′ C. The scale is continued by drawing line GH midway between O and D. Again line IJ is drawn midway between H and D. The divisions on line GH and IJ are transferred to line AB, and vertical lines are drawn as before. This scale halves on the 17th note as there are seventeen equal divisions on the line OF. Other scales may be drawn halving on the 18th, 19th or any other note, as desired.

to the scale of the pipes they make by number rather than in inches and one commercial pipe maker's 38 scale Diapason is very nearly the same diameter as another's. This number-scale is for the most part an arbitrary arrangement, but so long as it is well understood and generally adopted, it serves the purpose quite efficiently.

There is another matter which is important for the pipe maker to know before laying out the patterns for the construction of a set of pipes. This is the width of the mouth in proportion to the diameter, or circumference of the body of the pipe. The height of the mouth is usually determined by the voicer with a set of proportional dividers. Whatever proportion is desired may be maintained throughout the stop by setting the dividers for a given proportion, for example 1/4 or 1/3 width of mouth. The scales of reed pipes and wood pipes are referred to in both this country and England in terms of inches rather than numbers. Our chapter on voicing gives some particulars regarding the effect on tone of various proportions of widths and heights of mouths.

It is a simple matter for the pipe maker to lay out a scale designed to proceed evenly upward with a constant rate of diminution. If the dimensions of the CC pipe are given and the C above, he simply extends the scale upwards from these two points, though for greater exactness, and purposes of checking, frequently the diameter of all the Cs (or two dimensions in the case of wood pipes) are given.

Some builders have developed unusual scales that do not proceed upwards with unvarying diminution. Such scales have been evolved empirically, especially by builders who have made theater organs and other so-called "unit" work. These scales have been developed without much theory, but rather by actual experience. The Kimball Company and the Wurlitzer Company frequently employ a scale that causes the bass octave of a 16 foot stop to be of much greater size than the normal scale of the stop would indicate. This is done in order to get sufficient volume and weight of tone from the pedal extension of a manual stop. If the scale of an 8 foot manual Flute, for example, were extended down an octave lower with a regularly graduated scale, the resulting bass pipes would be too light and small in scale to make the tone properly effective as a pedal stop. The scale these builders have developed is in reality a hybrid type for a special purpose.

Another interesting scale that the Kimball Company have employed is what may be termed a compromise scale for the principal unison Diapason on the great organ. The wide low-mouthed Diapason on even moderately high pressure is quite satisfactory in speech and quality from middle C up and possibly a few notes below middle C. However, the 8 foot octave of this stop and part of the 4 foot octave, when made with the same wide, low mouth on wind of seven inch pressure or more, is not very satisfactory. The pipes are inclined to be slow in speech, windy, and unsteady. Consequently, the scale which this company have devised produces Diapasons with mouths much narrower and higher in the bass and in part of the tenor octave, gradually changing to wider, lower mouths as the pipes progress upwards.

This gives a bass of greater solidity and prompter speech, and still makes available the characteristic qualities of the more harmonically developed Diapason in the portions of the compass where it is most valuable and desirable.

For most artistic results, scales should be kept within certain well defined limits. Unless for some very special purpose, it is seldom desirable to make any Diapasons larger than 40 scale. The same rule applies to Flutes, where excessive scales should be avoided if the Flutes are to blend with the other stops in the organ. In the opposite direction, the scale should not be excessively narrow, as in the case of String tone, or unmusical and unblending tone will result. All tones in an organ should be truly musical. Excessive or immoderate scales, either large or small, will not contribute to this result. For best results in a Diapason chorus, the scales of all the components should be carefully proportioned to the principal Diapason rank. These proportions are given in our chapter on the Harmonic Corroborating Stops.

Figure 30 shows a method of drawing a pipe scale ingeniously developed by Mr. Joseph J. Carruthers, who has had more than fifty years' experience in organ building.

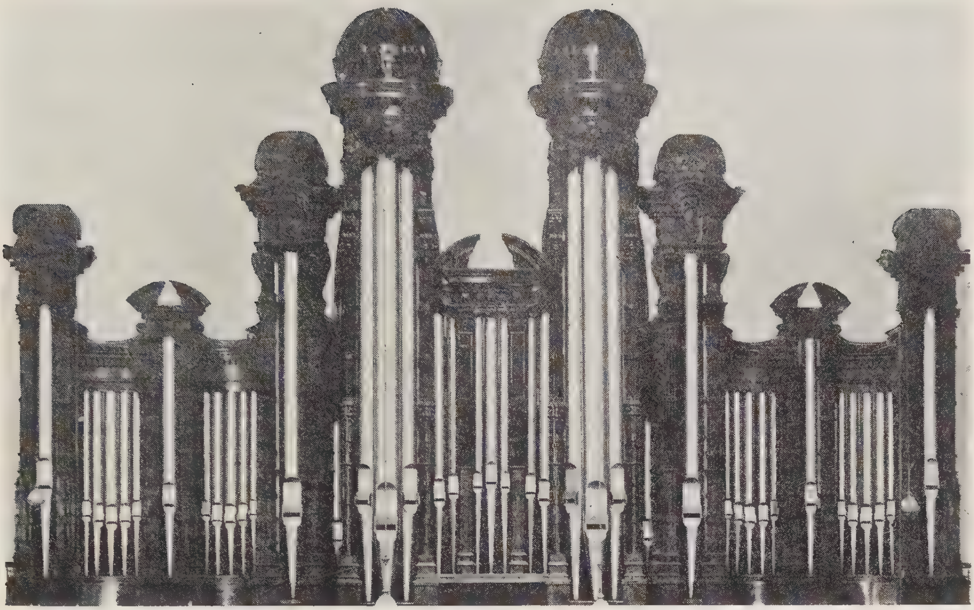


Plate VI.

The case of the world famous organ in the Mormon Tabernacle, Salt Lake City. The organ was originally built by the Mormons. Later the Kimball Company rebuilt it, and still later the Austin Organ Company has greatly enlarged its resources. The 32′ metal pipes stand in the central towers of the case.

CHAPTER 5.

HARMONIC CORROBORATING STOPS

THE late Dr. George A. Audsley used this expression to describe those stops which are introduced in an organ to reinforce the natural harmonics of the unison toned stops, and to give color, clarity, and brightness to the ensemble.

It is customary to arrange a number of these harmonic ranks to draw on one stop knob under the general term of Mixture. A Mixture must have at least two or more ranks of harmonic sounding pipes. Mr. Charles M. Courboin very aptly expresses the purpose of Mixtures as being to "fill in the chinks."

In the February, 1929 issue of the "American Organist," I wrote an article on Mixtures which I am reproducing as part of this present chapter. It covers the subject in a general way, although it by no means exhausts the many possibilities of this interesting field of organ building. The English conception of Mixtures is somewhat different from the notion of Mixtures advanced by Dr. Audsley. The latter recommended that the various ranks of the components of the Mixtures be made progressively much softer as they ascend in the scale. His proportions of tonal strength are given in my article.

The Rev. Noel Bonavia-Hunt, in his interesting work on "The Church Organ," states that the present day ideal upper work for the Diapason Chorus, (as exemplified in the organs built by "Father" Willis) is produced when the strength of the upper ranks of the Mixtures does not diminish in any such ratio as suggested in our article. Mr. Donald Harrison, a former partner of Henry Willis, states the same thing in his remarks which we quote on the Tonal design of the organ. Mr. Hunt states, "The principal four foot or octave Diapason should be more or less a duplicate of the unison Diapason, the scale being one pipe smaller and the upper lip being bevelled. The tone should be bright and only slightly less powerful than the unison rank. The 15th and 22nd are never so successful as when the scaling is small and when a wide low mouth is employed. Schulze's 2/7 mouth cut up 1/4 of its width or 1/5 diameter is a golden rule whose worth the author has proved by practical experiments." Mr. Hunt says further, "Two very common mistakes which are made in the treatment of Mixtures are the suppression of the octaves and the undue encouragement of the mutations." By mutations is meant all the ranks of pipes in an organ that do not speak either the prime tone or some octave of the prime tone. The mutation work usually speaks a fifth above the prime tone or some octave of the fifth above or below, though a seventeenth and a flat twenty-first are occasionally used.

Mr. Hunt makes one other point that is worth noting in his discussion of Mixtures and that is, "It has been a custom in the past to employ loud and high pitched ranks in the bass register of the manual keyboard, but the modern ear can no longer tolerate the disagreeable effect that this produces when the manual is coupled to the pedal; and in any case the balance between the bass and treble registers of the manual is upset by this treatment. This is an important point and vitally affects the question of Mixture composition, for it actually means that the Mixture proper ought not begin lower than middle C, with no mutation ranks and nothing higher than a twenty-second from CC to middle B." This is quite in line with what the eminent organist, Mr. Lynnwood Farnam, has had done in the organ which he plays in the Church of the Holy Communion in New York, where he has had two of the two-foot ranks changed into a Tierce or Seventeenth and a Larigot or Nineteenth from middle C upwards, simply by moving the pipes in their holes and leaving out those pipes that are not needed, keeping the lower two octaves at two foot pitch, as they were before. The effect which Mr. Hunt speaks of in the two bass octaves of the manual of these off-unison voices is peculiar and disagreeable to sensitive ears. Mr. Farnam has overcome this objection in precisely the way that Mr. Hunt suggests, by having nothing but the unison or the octave of the unison below middle C.

My article which is reproduced in the present chapter states that at least two types of Mixtures should be introduced into an organ with any pretensions to completeness—one Mixture to go with the Diapason Chorus and another Mixture, known as the Chorus Mixture, to top the Reed Chorus.

The Italians term the Mixture that is best adapted to complete the Diapason Chorus, "Ripieno," and its chief characteristic is that there is nothing but octaves of the unison and fifth, present in its composition, the tierce and septime being eliminated. Geo. Kilgen & Sons have specialized in this type of Mixture in this country. There is a third type of Mixture, viz: the timbre-creating Mixture which is an attempt to produce artificially all the natural overtones up to the fifth or sixth. Its purpose is frequently better served by arranging each component rank to draw separately. These ranks may then be used individually or in groups to "color" the tones of the unison ranks with which they may be associated. Such a use is most valuable. Most delightful and pleasing color effects are possible from a properly regulated series of harmonics of this kind. A unit Dulciana can be used to good advantage for such a purpose. However, as will be seen by perusing the chapter on "Transference of Stops," independent pipes are preferable because each rank can be more accurately regulated in strength for the effect desired. When these "timbre-creating" ranks draw separately, they perhaps do not properly constitute a Mixture at all but are simply mutation ranks for color purposes.

What the English builders consider proper Mixture work to go with the Diapason Chorus and other particulars (such as the point at which the various ranks of the Mixture break) are given by Mr. Hunt in his work "The Church Organ." As these details of construction are followed by some of our leading American builders, it is worth while to reproduce this model scheme for reference. There seems to be some misapprehension as to just what is required to produce a proper Diapason Chorus. The principal thing to be noted is that the octave is only slightly less in power than the unison Diapason. This is where many of our American builders have made a mistake in attempting to create a satisfactory Mixture effect. The octave is of the utmost importance to bring together the tone of the unison Diapason and the higher Mixture ranks. Its strength of tone, therefore, must be very carefully regulated to bridge this gap. It is of equal importance that the principal Diapason has considereable harmonic development, as was pointed out in our discussion of the various types of Diapason tone in order that the Octave when voiced as loudly as here recommended will not sound unduly prominent. In other words, the unison tone must have sufficient of its natural harmonics present to join with the artificial harmonics that are to be added to it in order to have a perfect blending of tone of great richness. This, of course, is the goal that is aimed at.

Mr. Hunt's complete scheme follows:

CC to C^4 = 61 notes—(Double 16 ft. and Open 8 ft.)

Principal, 4 ft. (one pipe smaller than Open 8 ft., ¼ mouth).

Fifteenth, 2 ft. (scale 1⅝ in. CC, 1 in. ten. C, ¼ mouth CC to BB, 2/7 mouth, ten. C up).

Twenty-second—CC to F^2 = 42 notes (scale 15/16 in. CC, 2/7 mouth).

Second Principal—$F\sharp^2$ to C^4 = 19 notes (scale as at 1 ft. C = 1⅛ in., 2/7 mouth, slotted).

Twelfth—mid C to C^4 = 37 notes
Nineteenth—mid C to C^3 = 25 notes   Scale as at 1 ft. C =
Fifth—$C\sharp^3$ to C^4 = 12 notes   1 1/16 in., 1/5 mouth.

Assuming the 16 ft., 8 ft., 4 ft. and 2 ft. to have separate draw-stops, the remaining ranks controlled *en bloc* by one draw-stop can be set out thus:

CC to mid B = 24 notes—22nd only
mid C to F = 18 notes—12th, 19th, 22nd.
F♯^{2} to C^3 = 7 notes—8ve., 12th, 19th.
C♯^{3} to C^4 = 12 notes—5th, 12th, 8ve.

61 notes

The complete scheme may be planned as follows, the 16 ft. rank being represented by ½, the 8 ft. by 1, and the 4 ft. by 8:

CC to mid B = 24 notes—½, 1, 8, 15, 22.
mid C to F^2 = 18 notes—½, 1, 8, 12, 15, 19, 22.
F♯^{2} to C^3 = 7 notes—½, 1, 8, 8, 12, 15, 19.
C♯^{3} to C^4 = 12 notes—½, 1, 5, 8, 8, 12, 15."

61 notes

In connection with his description of the Harmonic Corroborating Stops, or Mixtures, I was interested in reading in Mr. Wedgwood's excellent "Dictionary of Organ Stops," under the heading "Mixtures," the following: "The adoption of the pneumatic action and mechanical blowing at once opens up the path for the development of large-scaled foundation work and heavy pressure Reed work. The modern builder meets the requirement of large bodies of singers, not by a fierce din of Mixture work, but by a massive volume of good sustaining foundation tone, contributed alike by Diapasons and Reeds. In moderate sized organs, the most modern school of tonal design finds it possible—nay, even preferable—to dispense with even the Twelfth and Fifteenth, in favor of a soft Double Reed on the Swell. And certainly the modern Diapason is well able to maintain the essential supremacy of the Great Organ.

"The situation, it so happens, is rather embarrassed by the fact that Mixtures do not blend well with modern foundation work. This is not due to 'absurd wind-pressures' or any other of the familiar *betes noires* of the school of old-fogeydom, which clings tenaciously to the Georgian era of organ building. It is simply due to the fact that if a respectable foundation be added to an organ which is all 'top' the 'middle' will be found wanting, and its absence will cause a horrid lacuna, or gap, in the tonal structure, analogous to that in the familiar 'piccolo and drum' effect. The sole way to make powerful Mixtures 'blend' in the organ is to substitute for Diapasons something which, for want of more appropriate words, may be described as a hybrid between a Diapason and a Gamba."

We discover by this that even so sound a man as Mr. Wedgwood was smitten to a considerable extent with the Hope-Jones' idea that Mixtures might be dispensed with, at least in all small organs, and reliance placed on purity of tone, which Mr. Wedgwood states cannot be obtained with the presence of large quantities of Mixture stops, each with its own attendant series of harmonics. I have more to say about these ideas in my chapter on the "Tonal Design of the Organ."

We may now restate the whole subject of Mixtures by making use of my article in the "American Organist," referred to. It should be noted that the relative powers or strength of tone for the various upper ranks suggested in the article are those which Dr. Audsley thought proper, and these proportions are *not* in accordance with the "best English practice." They are, however, proportions that may suit the average American church, perhaps better than the English scales enumerated above. They may be safer, especially when the acoustical advantages of the church are below par.

"In the first instance let me state that the unsatisfactory character of the ensemble of many organs built during the past fifty years is due to imperfections in the tonal structure and an ignorance of the true acoustical laws directly bearing on tonal structure. It should be borne in mind that all sets of pipes introduced in an organ at a higher pitch than the prime or unison tone are introduced in strict accordance with the natural laws of sound with a view of substantiating or corroborating tones naturally present in the prime tone, but in an undesirably weak condition.

"All the orchestral string instruments as well as the human voice have a series of tones higher in pitch than those which are known as fundamental or prime tones, inseparably associated with the prime tones. It is owing to this fact and to the perfect proportion and combination of these overtones with the prime tones that the resultant compound sounds are rich and beautiful to our sense of hearing.

"Theoretically, a series of overtones has a great, if not a limitless upward range, but practically it is bounded by the very circumscribed power of the human ear. These overtones forming a series are known as harmonics, harmonic upper partials, or overtones of a prime tone. The prime tone is designated sometimes as the fundamental tone, ground tone, or prime partial. These upper partials bear a very definite relationship to the prime tone which in the more important upper partials is a simple proportion such as two, three, or four times the vibrations number of the prime. The upper partial tones most frequently used in the tonal structure of an organ that appear either as separate ranks of pipes or in a series that is drawn together as a mixture are the first seven.

"We will discuss, then, a series of harmonics that are to be introduced into an organ to reinforce the upper partial tones of an 8′ Diapason—which is the quality of tone in an organ that needs the upper partials reinforced more than any other organ tone, as it is particularly lacking in harmonic development of its own. This is the real reason for the use of harmonic corroborating stops in the organ.

"If all the pipes were of the Viol or String type of tone, there would be no reason either theoretical or practical for the introduction of Mixtures aside from the color—or timbre-creating value. The Chorus Reeds in particular are also rich in overtones and do not require Mixture work necessarily to make them sound satisfying and complete, as does the Diapason work. Therefore, to supply the lack (that nature supplies automatically in string instruments and the human voice) of upper partials, the Diapason tone is reinforced artificially or synthetically by a series of ranks of pipes. The principal rank of this series is the first upper partial which has twice the number of vibrations that the prime tone has, and sounds the octave.

"If it is assumed that the power of the prime tone is made to a scale equal to 100, the octave or first upper partial to properly balance this prime tone, should be of a power equal to about 70 on the same scale. The second upper partial has three times the number of vibrations of the prime, producing the 12th. This should properly be scaled at about 60 in power. The third upper partial has four times the number of vibrations of the prime and is the 15th. This might properly be scaled at 50. The fourth upper partial, not so frequently met with in mixtures, though a valuable harmonic, has five times the number of vibrations of the prime and is the 17th. This should be scaled considerably softer, say at about 40. The fifth upper partial having six times the number of vibrations of the prime is the 19th, and should be scaled at about 35. This sixth upper partial, seldom employed in the organ, has seven times the number of vibrations and is called Septieme or flat 21st. The seventh upper partial has eight times the number of vibrations of the prime and is the 22nd—or three octaves above the prime. Other higher partials are present in the human voice and in orchestral string instruments, but only those I have listed are used in organs, that form harmonious intervals with the prime. A set of upper partials such as has been enumerated and scaled to about the relative strength suggested (that is, becoming progressively softer the higher the upper partial) is in perfect accord with the acoustical phenomena as encountered in string instruments where these harmonics develop naturally.

"These upper partials, when introduced in a Mixture or compound stop, frequently double back on themselves or break an octave lower at one or two points in the scale upwards. Especially the highest partials have such small pipes that the practical considerations of producing the pipes themselves and tuning them after they are produced, make it impossible to carry them through the scale completely without doubling back.

"Dr. Audsley in his 'Art of Organ Building' states that the pipes of these upper partials have a peculiar, accommodating nature. He states 'If they are properly scaled and regulated to be in balance with the principal Diapason tone they will still be in proper balance when many more 8′ stops are added such as pipes of the Viol quality, harmonic Flutes, and Reeds.' He quotes in substantiation of this assertion the five-rank Dulciana Mixture in his own chamber organ which he states was soft enough to be agreeable with a single solo voice and yet was adequate to the full organ. From my own experience I have found this is true only to a limited extent, and though there is undoubtedly a certain amount of leeway, a Mixture soft enough to be used with a single solo stop or even a single 8′ Diapason is entirely inadequate to supply the upper partial development for the full organ.

"I was particularly impressed with this fact in trying the two Mixtures in the Swell Organ of the Casavant in Tremont Temple, Boston. A magnificent Full Swell of some 25 stops, with 16′, 8′ and 4′ chorus Reeds, exists in this organ. The two Mixtures could be drawn with the foundation work, Strings and Flutes, and be exactly the right strength, but when the brilliant Chorus Reeds were added the Mixtures could be drawn on or shut off without adding or detracting anything from the ensemble. It therefore appears to be essential that if there is to be sufficient Mixture work in an organ, at least two different Mixtures are required, one designed and regulated for Diapason work, and one to be drawn with the full organ as a crowning touch, or what is sometimes termed the Grand Chorus Mixture.

"I refer now to the requirements of large organs; ordinarily a four-rank Mixture of medium strength is all that is necessary in an organ of moderate size, with the addition of two or three upper partials drawing separately, such as a 12th and 15th, with, of course, an octave.

"If the Reeds are sufficiently dominant and are of the brilliant Trumpet quality, especially if there is a 4′ Clarion, a powerful Mixture seems to be entirely unnecessary in the ensemble, as there is quite sufficient harmonic development in Reeds of this character to require no outside assistance.

"Practically every organist is familiar now-a-days with the upper partials that are taken from a unit Flute or a Dulciana and these are reasonably satisfactory for certain purposes, such as color, up to the third upper partial or 15th, but beyond this the discrepancy in power and tuning is usually too great to make the pipes useful when used as a separate harmonic such as the 17th or Tierce. It should be borne in mind that these ranks such as a Unit Flute or Dulciana by no means take the place of a true Mixture which is properly scaled and balanced so that the higher partials decrease in force as they rise in pitch in accordance with the acoustical phenomena of nature. A Unit Flute with these partials, however, in a small organ is a fairly good make-shift or substitute for Mixture development, as far as it goes. The quality of tone is wrong, however, for blending and amalgamating with the prime tone of the Diapason, which as before stated is the principal tone that needs the reinforcement of its upper partials.

"The whole subject of Mixtures and harmonic development is full of interest and has by no means reached the artistic limit that it will some day.

"The almost complete neglect of the subject for many years in this country, because of the inartistic and screamy Mixtures that formerly were introduced in organs, was as bad in its extreme swing, as were the screamy Mixtures that were done away with altogether. A sane and sensible return to Mixtures is much to be desired."

In the present chapter, as well as the chapter on the Tonal Design of the Organ, I do not wish to convey the impression that the renewed interest in the subject of Mixtures was created entirely by the first visit of Henry Willis to this country. This has had important effect in its subsequent influence on the Skinner Organ Company and other builders. It has been marked by a return to the systematic introduction of these stops in the organ.

However, before Mr. Willis' visit, Senator Richards, with the enthusiastic cooperation of the Midmer-Losh Company, designed a large organ for the Atlantic City High School, which introduced Schulze Diapasons, and complete Diapason Mixtures, on a scale that had not before been attempted in America. This organ also contains a series of beautiful mutations produced from a unit Dulciana, and other soft units, that carry the mutation idea from unit stops to its ultimate conclusion. It is only fair to say that this organ had great influence and caused reawakened interest in this country in Mixtures, with proper harmonically bright Diapasons to go with them.

St. Mark's Church, Philadelphia, a little later, had a gallery organ installed with Senator Richards' design and executed by the Midmer-Losh Company, in which a most elaborately developed Diapason Chorus was present. In the enormous organ in the Atlantic City Auditorium now being built under the same auspices, harmonic corroborating stops surely come into their own.

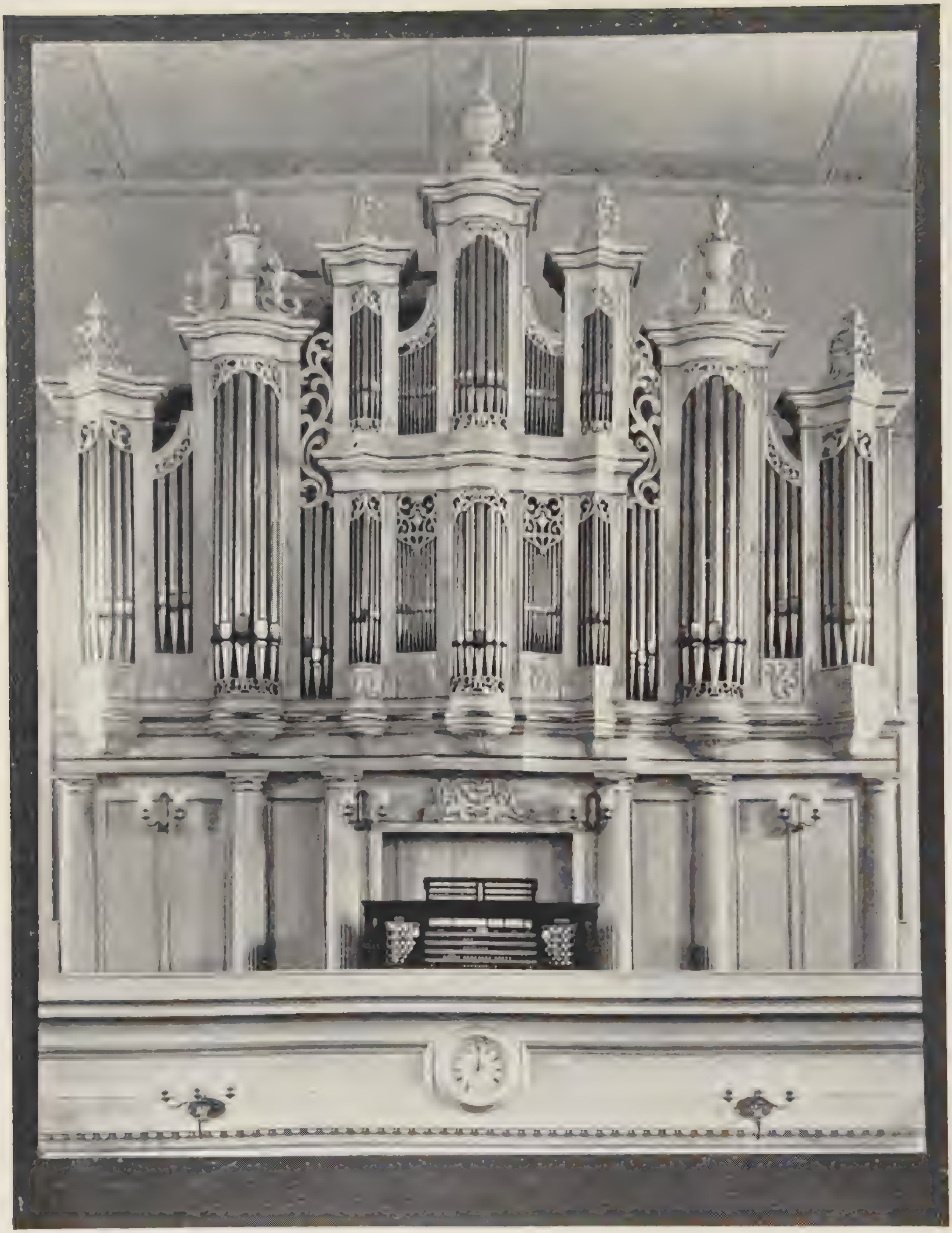


Plate VII.

An American Organ Case of 1774, with Colonial designs, in white and gold. It was built by David Tanneberger of Lititz, Pa., for Trinity Lutheran Church of Lancaster, Pa. The organ was rebuilt in 1923, at which time the wings of eight pipes were added to each side of the case. The main portions of the case work have been preserved intact.

CHAPTER 6.

VOICING *of* ORGAN PIPES

IN our chapter on "The Sound Producing Portions of the Organ," information was given as to some features of "voicing" the various types of organ pipes, particularly with regard to Reed pipes. The present chapter aims to consider the whole matter more fully and logically. Voicing is an art and it should demand the utmost attention of the artistic organ builder.

When the pipes leave the hands of the pipe maker, they are passed on to the voicer to regulate the height of the mouth and determine the manner in which they shall be "nicked," and such other operations as are necessary until the pipes produce the quality of sound that is desired. Before the pipemaker can begin construction, the scale of each set of pipes has to be determined, also the quality of metal as well as its thickness. The shape of the languid, and the width of the mouth, must all have been definitely decided. The tonal director or head voicer usually decides these matters. He also frequently voices completely the middle C and perhaps the other C's of all stops as a model for the other voicers to follow.

When the pipes come to the voicer, they are merely so much metal or wood made in the form of organ pipes, usually without being capable of sounding a note. They leave the voicer as finished instruments of music, according to his skill.

The various stops of the organ in a general way may be compared to an orchestra, the number of stops or voices the organ contains, representing the instruments in the orchestra. A great difference exists between organ pipes and orchestral instruments, however. In the case of orchestral instruments, one, or at most two, are capable of covering several octaves, if not the entire range of the organ keyboard. Whereas, in the organ every separate note of every distinct stop must be represented by a pipe. If, for example, we take a French Horn, it will have sixty-one or seventy-three pipes; in the orchestra a good part of this range may be covered by a single instrument, capable of playing, however but one note at a time, whereas an organ stop may play any number of notes simultaneously.

One of the chief functions of the voicer is to cause all the pipes of a stop, both individually and collectively, to be of a certain "timbre," characteristic of that stop, and to avoid as far as possible any discrepancies between one pipe and another. This is obviously much easier for the voicer if the pipes are carefully scaled and constructed. If this is not the case, even an expert voicer will have difficulty in obtaining proper results. Voicing requires both patience and skill. Naturally, it is important to know that the precise quality, or timbre of any musical instrument (organ pipes included), is determined by the nature and the degree of development which is given to the series of upper harmonics or partials. Our chapter on "The Harmonic Corroborating Stops" gives some details in regard to these harmonics.

When a musical note produced from a Flue pipe is characterized by an ample harmonic development so that all the upper partials or overtones sounding above the prime are prominently in evidence up to the twenty-second note above the prime tone (which tends to obscure that tone), such a pipe belongs to the group known as "String" tone.

When the note from a Flue pipe is deficient in overtones and the prime tone is much more in evidence, it belongs to the class known as "Flute" tone. The mean between these two extremes of greater or lesser harmonic development will produce Diapason tone. If this were geometry, I might say that it should be self-evident from this that the timbre of a note is dependent upon the degree of harmonic development present.

The timbre may be further affected by the suppression of certain partials in order to lend prominence to others and, if all of the upper partials are suppressed in favor of one, many peculiar and subtle shades of tone may be produced.

The Clarinet is an instance where only the odd series of harmonics (the prime, twelfth, seventeenth and flat twenty-first) are permitted to develop, the even series (octave, fifteenth, nineteenth, twenty-second) being scarcely present at all.

Again the pipe may be constructed with a hole at its node (a point near the center of the pipe), that upon being overblown will not sound its prime tone at all but its octave. A stopped pipe may be overblown to sound its twelfth or seventeenth, the prime being eliminated, in this case by keeping the mouth low and boring a hole through the pipe at the nodal point. Or a stopped pipe may be caused to sound the prime tone along with its twelfth, almost equally, as in the case of the quintation. It is the function of the voicer to control the harmonic or non-harmonic tendencies in the speech and tone of the organ pipes which he voices.

The Rev. Noel Bonavia-Hunt* in his work, "The Church Organ," gives the following list of factors which influence the speech and tone of Flue and Reed pipes:

---

*Mr. Hunt's remarks are quoted both in our chapter on the "Sound Producing Portions of the Organ" and in the present chapter extensively, as he is not only a practical voicer but is able to describe what he knows, in clear English; a combination that is as rare as it is valuable in discussing so technical a subject as the construction and voicing of organ pipes.

"FLUE PIPES

1. The scale (i.e. diameter) of the pipe-body.
2. The area of the mouth (i.e. its width and height).
3. The shape of the languid of a metal pipe, and the shape of the block of a wooden pipe.
4. The adjustment of the relative positions of the upper and lower lips and of the languid of metal pipes.
5. The shape and position of the cap of a wooden pipe.
6. The character of the nicking.
7. The pressure and the volume of the wind supplied from the windchest.
8. The size of the bore of the pipe-foot.
9. The employment of various devices and accessories.
10. The material of which the pipe is made.

REED PIPES

1. The shape and length of the tube (or resonating body).
2. The scale (or diameter) of the tube at the top.
3. The pressure of wind from the windchest.
4. The shape and size of the shallot (or reed).
5. The shape and size of the shallot opening (or orifice).
6. The thickness, width, vibrating length and curvature of the tongue (or bass vibrator).
7. The employment of various devices and accessories.
8. The material of which the tube is made."

The power, that is, loudness or softness, of metal Flue pipes is chiefly regulated by the size of the scale, and the bore in the foot that admits the wind. Large scales and a large hole normally produce a loud note, whereas small scales and a small bore will normally produce a soft note. The power is also regulated by the wind pressure employed, as with a given size scale and hole in the foot of the pipe and, within certain limits an increase in pressure will produce corresponding incease in power.

Mr. Hunt lists the manner in which upper partials are encouraged in metal Flue pipes as follows:

"1. Small scales.
2. Low cut-up of mouth.

3. (a) Concave and (b) bevelled upper lip.
4. (a) Raised and (b) acute-bevelled languid.
5. Fine nicking.

The upper partials are normally discouraged by:

1. Large scales.
2. High cut-up of mouth.
3. (a) Convex and (b) thick, arched or leathered upper lip.
4. (a) Depressed, (b) obtuse-bevelled, (c) inverted languid.
5. Bold nicking."

A pipe is made to speak promptly, by having the upper lip pulled slightly outward, also when the languid is pressed slightly downward. If this is done to too great an extent, the pipe will "fly off its speech" and sound its octave.

If the upper lip is too far inward, and the languid too high, the speech tends to "come on" or "develop" slowly. If this is overdone, the pipe will become silent altogether.

Another important operation in the voicing of Flue pipes consists of nicking the front edge of the languid and lower lip, so that they resemble somewhat the teeth of a saw. These nicks are necessary to prevent the pipe from being windy when it speaks. The narrow windway between the edge of the languid and the lower lip (through which the wind passes when the pipe is speaking) is, by the process of nicking, broken up into a series of air columns and thus better focused on the upper lip. It converts in effect the action of the wind stream into an atomizer.

Delicate tones and many types of String tone are best produced when the nicks are close together and not very deep. Coarse and deep nicking, with the nicks farther apart, produces bolder and more flutey tone.

The voicer next considers the height of the mouth. This normally bears a fixed proportion or ratio to its width. The width of the mouth must be determined before the pipes are made as has already been indicated. Ordinarily, pipes with wide mouths tend to have greater harmonic development than those with narrow ones, when the height of the mouth remains the same. When the low mouth is made wider, the resulting tone from the pipe has more harmonic development. When a high mouth is made wider, it produces more foundation tone. The opposite effect is true when the mouth is narrowed, in which case a low mouth will produce fewer harmonics and a high mouth less foundation tone.

The width of the mouth is measured in accordance with the proportion it bears to the internal circumference of the body of the pipe. The circumference is roughly 22/7 of its diameter and, if we suppose a pipe, for example, that is 3 1/2 inches in diameter with a mouth 2 3/4 inches wide, we may state that the mouth in this instance is a quarter of the circumference. (22/7 x 7/2″ = 11″ = circumference ÷ 2 3/4″ = 4. The circumference is four times the width of the mouth).

The height of the mouth is usually measured in accordance with the proportion it bears to the width of the mouth. It may also be measured in accordance with the proportion it bears to the internal diameter of the pipe body. The former method is usually the one employed by pipe makers and voicers. Therefore, if the mouth referred to as being 2 3/4 inches wide is cut up 7/8 of an inch in height, it is said to be cut up 1/3 of its width or 1/4 the diameter of the pipe. When the pipes are made, the upper lips are left longer than necessary to afford the voicer opportunity to cut them up to the proper height. If the upper lips are cut too high to start with, it may be necessary to have new pipes, as not much can be done with them.

Wood pipes are treated for the most part like metal pipes in the voicing, but inasmuch as the material out of which they are made is not capable of adjustment as in the case of metal pipes, a certain difference in treatment must be followed. There is not very much that a voicer need do to wood pipes after they are made. The width of the mouth of a wood pipe is necessarily determined in most instances by the width of the side of the pipe which contains the mouth, though in special forms of wood pipes the mouth is not always the entire width of one side of the pipe. Nearly all modern wood pipes are provided with metal toes, which may be reamed out or pounded in to adjust the amount of wind that is admitted to the pipes. This is a great convenience to the voicer as formerly wooden pipe feet were plugged with little slips of wood which had to be adjusted to a nicety.

One of the refinements in voicing that is sometimes overlooked is the removal of all rough or sharp edges along the pathway of the wind stream as it flows to the mouth of the pipe. Any sharp edges or corners such as may be left when the feet are reamed out should be carefully rounded off, or the pipes are apt to be windy and unsatisfactory in tone. This applies to both metal and wood pipes.

The treatment of the upper lip of both wood and metal pipes also has some effect on the tone. For example: a sharp, keen edged upper lip produces more harmonic development and a thick and rounded upper lip produces more foundation tone. The Hope-Jones type of Tibias and Phonon Diapasons have the upper lips both rounded and leathered. This tends to make the tone extremely foundational in character. The smoothness which is thus engendered into the tone of Flue pipes so treated tends to become cloying after a time. Organ pipes, if properly

52260

treated should last for hundreds of years, and perishable material, such as leather, is of course undesirable for use in them.

The fitting of harmonic bridges or rollers for steadying the speech of String toned stops, though usually done by the voicer, has been described in our chapter devoted to The Construction of Flue pipes. The voicing of Reed pipes has also already been considered in our chapter on the Construction of Reed pipes, to which the reader is referred.

The art of voicing is one that can only be learned by experience and while some information is afforded by the written word the actual technique and skill required in this operation is a matter requiring years of application before proficiency is attained.

FINISHING OF ORGANS

Another department of voicing consists in the final finishing and regulating of an organ after it is installed in its permanent location in the church or other building. This matter is a most difficult one for the organ builder to handle in a satisfactory manner. Competent and experienced organ finishers are scarce and from the nature of the work are apt to be temperamental. Several of the best organ finishers whom I happen to know in this country are inclined to be somewhat unreliable, and on occasion consume more alcoholic stimulants than is good for them. Whether this should be the inevitable accompaniment of an artistic temperament (which it is desirable for an organ finisher to have), is somewhat of a question. It is not too much to say that the work of finally finishing and regulating the tone of all the pipes in the organ is one of the most important, and frequently the most neglected, matter in organ building.

No matter how carefully the pipes are constructed, nor of what excellent material, and no matter how reliable and efficient the mechanism of the organ, if the final finishing is not properly carried out, the effectiveness and true musical value of the organ will be largely lost. Pipes constructed with indifferent workmanship and materials may be made to sound much more satisfactory when carefully finished and regulated than much better pipes will sound that are not properly finished and regulated. The finisher requires a good ear, judgment, discernment and, a knowledge of how to proportion the relative dynamic power of the stops to build up a beautiful and even ensemble.

It is not enough that each pipe in a given stop be of the same timbre or quality as all the other pipes in that stop. Each pipe must also be regulated to a nicety in regard to volume so that there are no loud or soft notes standing out as the series of pipes are sounded, one after the other. These matters are, of course, important. When the pipes come from the voicer, these qualities should have been taken care of. The skill of the finisher lies in adjusting the relative strengths of the various stops so that the organ will build up evenly, and gradually, without serious breaks or jumps in the strength of tone as one by one the stops are added. The various voices must be capable of not only gradually being built up, but must be so adjusted in strength of tone, one to the other, that the greatest number of combinations possible of the various voices will be pleasingly balanced and proportioned. Such a balance will insure good blending qualities.

The octave, sub-unison, and Mixture work of the Diapason section must be accurately proportioned in strength of tone to the foundation Diapasons. There must be sufficient difference between the various unison Diapasons in both strength and quality. The same is true of all the other classes of organ tone.*

A very indifferently constructed organ properly finished and regulated may be made to sound more truly musical, and far more pleasing to the cultivated ear than the most carefully constructed instrument possible of finest materials, that has not been so fortunate in final finishing. Organ builders know this, and do their best to secure such finishing of their organs. Unfortunately it is extremely difficult to supervise men a long distance from the factory especially when the builder is making several hundred organs a year. The organ builder has in many cases to rely solely upon the judgment and competence of the finisher for the final result. This is inevitable, in a country as large as the United States where distances are so great. In England it is possible for the principal tonal director of the builder, personally to supervise the finishing of at least all that builder's important organs. There would be better organs in this country if this were the case here. I have come to the conclusion that a finisher who is thoroughly competent and conscientious is one of the biggest assets that any organ builder can have. It is really vital. Nowhere in the construction of so complicated an instrument as the organ, is it desirable or advisable to cut corners on either material or workmanship. But, if it must be done, I would rather it were done anywhere else but in the final finishing. Even if the organ is not so reliable mechanically as it might be, when it does work, a beautifully finished organ will be worth listening to and a joy; whereas, the most reliable organ mechanically will be disappointing and unsatisfactory to the listeners if the pipes are not regulated to blend and build up properly. After all, efficient and reliable mechanism and convenient gadgets on the console for the organist are all valuable, and much of this book is devoted to their description, but all that the listener of the organ cares about or knows, is what he hears. What he hears, must be *right* first of all. Mechanical matters come second. Some builders have unfortunately placed the emphasis the other way around.

---

*A story is told of a very particular, not to say fussy, organist, who took a large part in the final finishing of a very large organ. The organ finisher was up in the organ which was located at considerable distance from the console. The organist was regulating a soft register by running over the keys, and picking out loud and soft pipes to be adjusted by the organ finisher. Finally, he yells to the finisher, "Is that F sharp sounding," The finisher yells back, "Yes." The organist replies, "Well, make it softer." This story should take the prize as the ultimate in organ finishing.

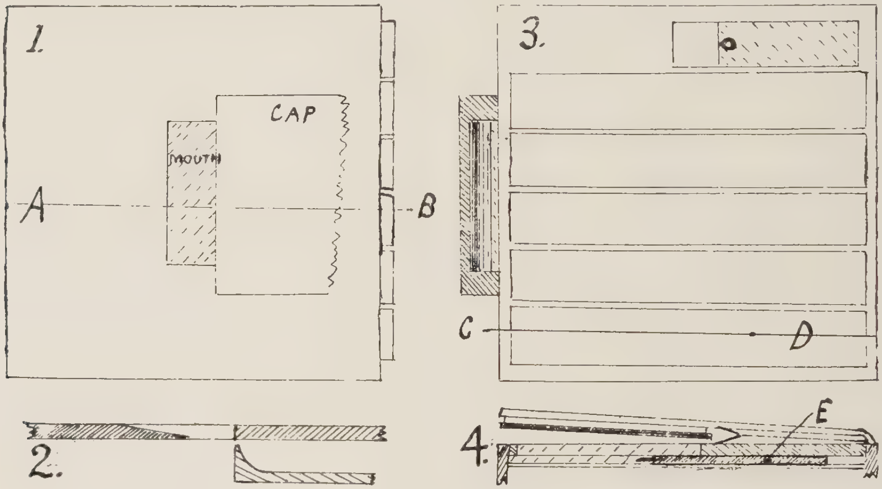


Figure 30-a.

Cube invented by Mr. John Compton. This store-box arrangement gives seven tones, replacing some of the lowest notes of a 32′ pedal register. Figure 1 shows the front of a Cube, with the Mouth in evidence. Figure 2 shows a section through Figure 1 at the line A-B. Figure 3 gives a view of the side, with the motor removed from the top position so as to show the Tuning Slide. A sectional view through the line C-D is given in Figure 4, with the motor inflated, and the Tuning Slide shown at E.

Plate VIII.

Liverpool Cathedral. Henry Willis and Sons have here built the largest organ in England.

CHAPTER 7.

TUNING *of* ORGAN PIPES

HAVING given some particulars concerning the construction and voicing of the various classes of organ pipes, we shall now consider how they are tuned.

It is a curious circumstance that, though Johann Sebastian Bach invented and used the system of tuning in equal temperament, nearly two hundred years ago, equal temperament was not introduced into English organs until 1852. Bach demonstrated its advantages in a series of studies called "The Well-Tempered Clavichord."

It should be noted that the modern keyboard is imperfect. One black key is made to serve for example for D sharp as well as for E flat, whereas the two tones are in reality not identical. To secure correct tuning in the intervals throughout, at least forty-eight keys would be required to an octave instead of the twelve that are now made to suffice. In what is called the equal temperament system the attempt is made to divide the octave into twelve equal parts or semitones, thus rendering all keys alike. To do this, it is necessary to slightly flatten or narrow all the fifths and slightly widen or sharpen all the fourths, resulting in considerable sharpening of the major thirds and sixths. The difference in just intonation is about a fiftieth of a semitone.

There are no doubt ears so sensitive that the sharp thirds and fourths and the flattened fifths and other discordant intervals of our modern keyed instruments are a considerable source of pain, but the average organist and pianist has become so accustomed to the defect that he fails to notice it.

To tune in equal temperament, is in reality to divide up the twelve semitones in such a manner as to compromise between the out-of-tuneness of the intervals, rendering no intervals perfect except the octaves and unisons, and no intervals too badly out of tune to make their use highly unpleasant.

There is no mystery about tuning an organ or piano and it does not require a musical ear, as that term is usually understood. It does require, however, an ear keen enough to be able to detect the wave beats that occur when two pipes or two strings are sounded that are not tuned to perfect intervals. These wave beats are caused by interference in the sound waves of two or more sounding notes. The beats are never present when the ratio of the frequency of vibrations produced by the two pipes, or other musical tones, may be expressed in some simple ratio such as 1 to 2, or 2 to 3. Therefore, when a note is sounded with its octave above and no wave beats are audible, it is in tune with its octave and if the octave is absolutely true to pitch then the lower note must also be true to pitch. In other words, both are in tune.

It is customary to tune the 4 foot Diapason in the organ or one of the keener toned 8 foot Strings first throughout as nearly perfectly as possible. Every other stop of the organ can then be tuned to it.

If, for example, we wish to tune the Trumpet 8′, we can draw the Octave 4′ with it and tune each note by eliminating the beats caused by the Trumpet being out of tune with the Octave. Every other stop in the organ can be subjected to the same treatment, until all are in tune with the octave and therefore with each other. This is a comparatively simple process and one which some organists know how to accomplish.

The only difficult matter is that known as "laying the bearings" or "setting the temperament" on the tuning stop, from which the rest of this stop may be tuned, and after that the balance of the organ. To lay these bearings, the tuner has to diminish all the fifths and widen all the fourths and at the same time keep the octaves perfect, as stated above. As a practical matter, the fifths are generally first tuned perfectly, that is, with no beats and then slightly narrowed, so that a slow beat is produced. In the middle section of the keyboard from F below middle C to F above on an 8 foot stop, the beats that occur when fifths are held should be about three beats to five seconds. The fourths are first tuned perfectly and then slightly widened. The widening of the fourths is slightly greater in extent than the narrowing of the adjacent fifths, or about four beats in five seconds.

Taking middle C as a starting point, we may hold the G above, which is a fifth. The G is tuned to sound a perfect non-beating interval with the C below, then the G is slightly flattened until a slow wave beat is perceptible. Still holding middle C, we take the F above, or the fourth. This interval is tuned perfectly and then the F is slightly sharpened so that it beats with the C below. The beat of the C-F interval, or fourth, is a little quicker than the beat of the C-G interval, or fifth. The pitch of the F and G will be correct and of equal temperament.

The reason why the out-of-tuneness of the fourth should be greater than that of the adjacent fifth is because the rate of the beats of C and F above is equal to the rate of beats of F and the C above middle C, that is, the higher in scale the interval occurs the quicker the beats.

The organ tuner proceeds throughout the scale of the twelve semitones by fourths and fifths, tuning them in succession. When the scale has been completed, the test is to find if the last interval tuned will come out correctly with the starting point, or middle C.

Test intervals of major thirds and sixths can be, and usually are, employed during the process of tuning the various fourths and fifths.

In the part of the scale we have suggested the major thirds and sixths have a quite rapid beat which is very easily detected when carefully listened for. The rate of these beats is very sensitive to slight changes in the pitch of either element of the interval. Therefore, by making use of the major thirds and sixths, a test of the work may be had as the tuner proceeds, without waiting until all the fourths and fifths have been tuned and the original starting point has been reached.

An expert tuner can set the temperament the first time around, whereas a less experienced tuner may have to go over these intervals a good many times to make the proper adjustments so that each interval will be equally out of tune and no interval will be too perfect at the expense of some other interval that will be too violently out of tune to sound even passably well.

The whole matter of tuning by equal temperament is a compromise, and expert piano tuners have told me that it "gets on their nerves" after many years of it, because they can never tune perfectly. The principles underlying piano tuning and organ tuning, particularly in regard to "setting the temperament," are precisely alike. As both instruments have twelve semitones to the octave, there must necessarily be a compromise.

The pitch of the Flue pipes is altered by lengthening or shortening the pipes themselves, thereby flattening or sharpening them respectively. Formerly all the metal Flue pipes except the large sizes were tuned by having the tops of the pipes coned in for flattening and coned out for sharpening by means of brass tuning cones or horns. This was an objectionable practice, as the constant beating on the tops of the pipes, especially by a careless tuner would tend to pound the body of the pipe down on to the languid or otherwise injure the pipe, to say nothing of endangering the soldered joint at the top of the pipe.

A somewhat better means of tuning, generally employed for many years, was to slot the pipe near the top and the metal cut out of this slot was rolled down to a point which would bring the pipe in tune. When this style of tuner is adopted, the pipe must necessarily be made somewhat longer.

A much better method of tuning metal Flue pipes is the one which is now nearly universally adopted. It consists of applying cylindrical slides, usually made of tin plate, that fit the tops of the pipes with a certain amount of spring, so that they will stay firmly where they are placed and yet are capable of being knocked up to flatten the pipes and knocked down to sharpen them. These tin plate tuners on the larger pipes are usually held in place by a clamp or friction tape, so that there is no danger of their sliding out of position.

The larger open wood Flue pipes are tuned, preferably by a wooden slide that is capable of being adjusted up or down in a slot cut near the top of the pipe. The smaller wood Flue pipes have pipe metal flaps fixed on to their tops which can be opened up and closed down like a trap door. This method of tuning open wood pipes is not as desirable as to leave the pipes long enough so that a roll tuner may be applied at one edge of the top of the pipe, covering an area too small to affect the tone quality. This latter form of tuner is not in danger of falling down from its own weight, as sometimes happens in the case of flat metal tuners.

All stopped wood pipes are tuned by means of the stoppers at the top of the pipes, the stoppers being knocked down to sharpen, and drawn up to flatten the pitch.

Reed pipes are tuned by means of a small spring wire which passes through the Reed block. The tuning wire shortens the vibrating portion of the tongue when it is knocked down (thereby sharpening the note) and lengthens the vibrating portion when raised up (thereby flattening the note). The slots cut near the top end of the tubes or resonators with the pieces of metal so cut out and rolled down, are intended for regulating the power of the pipes, and are not generally used for tuning purposes. Similarly the slides or collars sprung on to the tops of the Clarinet are for regulating.

There are exceptions to this rule, however, as for instance when a sudden change of temperature will interfere with the scientific relationship that exists between the tube length and the length of the vibrating tongue. In such cases, if the tongues be readjusted to the altered tube length, the pitch of the pipe will be rectified at the expense of its tone and perhaps the general regulation of the stop as a whole. In this instance, if the pitch is adjusted by regulating the tube at the slot, the tone and pitch can both be maintained at their original standard.

Ordinarily, it is not desirable to tune either the Flue pipes or Reed pipes of an organ except at a normal or standard temperature. The pitch of all pipes in the organ is affected in greater or lesser degree by changes of temperature. The pitch of wood pipes is affected also by changes in atmospheric conditions, such as extreme dryness or dampness, even though the temperature remains constant, because the actual dimensions of the pipes are changed by shrinking and swelling of the wood. The wood pipes will nearly always have to be tuned after a prolonged dry spell, or after a prolonged season of dampness.

Mr. Skinner in his work on the "Modern Organ" gives perhaps the best explanation as to why the pitch of organ pipes varies with changes in temperature. He states, "It is well known that the more forcibly a pipe is blown, the sharper its pitch becomes. A change in temperature does not affect the wind pressure which remains constant. Consequently, a sheet of wind issuing from the mouth of a pipe always has the same degree of intensity. As the temperature rises, the pipe contains less air than before, as some has left it through expansion. The remainder is lighter than formerly, and it is therefore more forcibly excited by the wind sheet, as the latter has not changed. The pipe is, in effect, blown harder. As the air becomes cooler, the process is reversed and the pitch flattened."

It might be assumed that the pipes of an organ should grow flatter in pitch as the temperature rises because the additional heat would cause the metal in the pipes to expand. Such is not the case. It appears that this factor is practically negligible, but that the heat causes the *air* in the pipes to expand, and therefore permits the rarified air to be more forcibly excited by the wind sheet. This explanation seems logical and certainly agrees with the facts—a desirable quality for an explanation to have.

So sensitive are the smaller pipes, particularly, to slight changes of temperature that the warmth of the tuner's hand, if he should apply his hand to the top of the pipe for the purpose of changing the position of the tuner, even momentarily, will materially affect the pitch of the pipe. Upon the pipe so treated again reaching its normal temperature, it will be found to have materially flattened. It appears, then, that the first rule for any tuner to follow, when actually tuning an organ, is to stay as far away from the pipes as possible with his hands or body. Ordinarily a chisel, or equally flat piece of steel is used (in tuning both the Reeds and Flue pipes), of such length as to allow the tuner to stay a respectable distance from the pipes themselves.

Mr. Skinner has also a very ingenious and I believe correct explanation of why Reed pipes have a tendency to fly off their speech in a cold church. He states that, "if a Reed is tuned too sharp, that is too short a length of tongue in proportion to the length of the resonator, it has a tendency to break into an interval above, as the resonator is then too flat in pitch for the tongue. This is a case identical in principle with that in regard to Reeds in cold buildings. The temperature has not greatly affected the tongues but it has increased the density and consequently the amount of air within the pipes, made them proportionately flatter, giving them the same tendency to fly off that is noticed when they are tuned too sharp on the tongues." In other words, the natural vibration period of the tongue and resonator must be maintained at a fairly definite proportion.

Modern organ Reeds, as was noted in our chapter on Reed Pipes, stay in tune vastly better than formerly. The use of thicker tongues, and thicker tuning wires both contribute to greater stability of tuning. The tuning wires should preferably fit quite tightly where they pass through the Reed block. When the Reed pipes have full length resonators, as in the case of Trumpets and Chorus Reeds of most descriptions, they are affected by changes in temperature very similarly to that of the Flue pipes themselves, and are consequently apt to be quite well in tune with the Flue pipes, even though there has been a material change of temperature since the organ was tuned. The pitch of such Reeds is very strongly influenced by the size of the resonator and the air becoming more rarefied or compressed in the resonator tube produces a similar effect on the pitch of the Reeds as its does in the case of the Flue pipes.

In the case of Reed stops with short resonators, such as Vox Humanas, Orchestral Oboes, Clarinets, etc., the resonator does not have so strong an influence on pitch. The reed tongue itself is very little affected by changes of temperature. These pipes tend to remain at a more constant pitch than the other pipes in the organ. Instead of the Vox Humana being out of tune, it has remained at the pitch at which it was tuned and the rest of the organ has either sharpened or flattened from this pitch, if there has been a considerable change in temperature (colder or warmer from that at which the organ was originally tuned). As a practical matter, it is much easier to tune the Vox Humana or Orchestral Oboe than to tune the rest of the organ to these stops.

The standard pitch of the organ has varied from time to time from C = 545, down to c = 517.3 or A = 435. This latter pitch is generally adopted today as being more suitable for accompaniment of the voice, and for use in conjunction with the modern orchestra. This pitch is equivalent to the standard American pitch of C= 522 or A = 440 at 70 degrees. The pitch as stated of C = 517.3 for 60°, at which temperature most English organs are tuned (the churches in that country are seldom above this point) will almost exactly correspond with the present American standard that C = 522 at 70°, which is the standard temperature for tuning American organs.

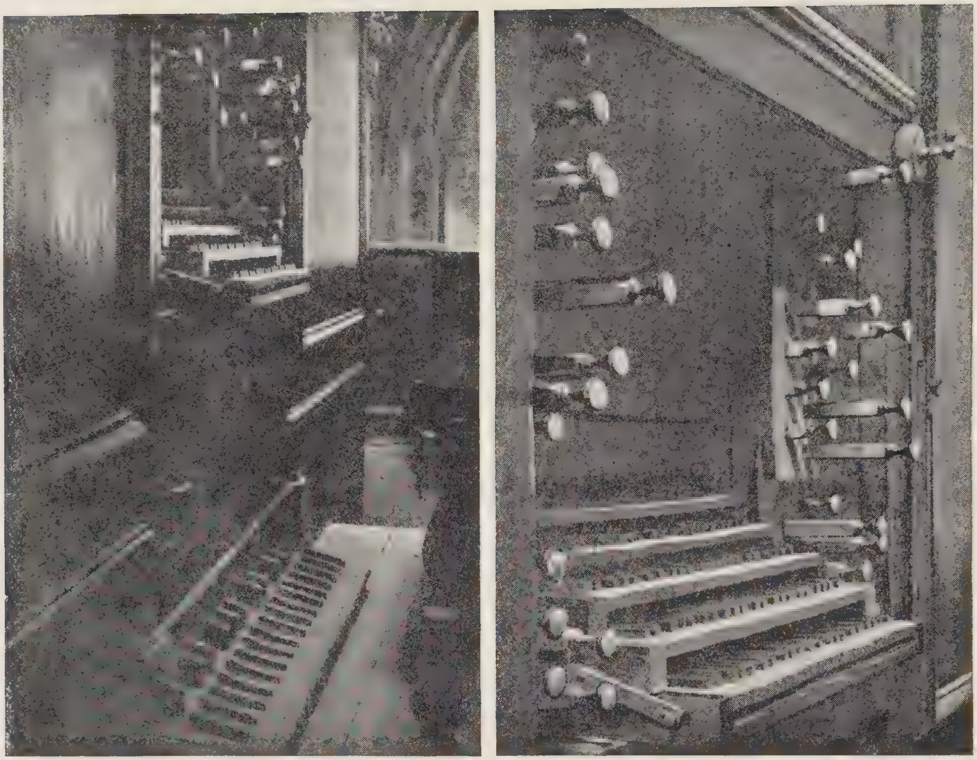


Plate IX.

Console of St. Gervais, Paris. They began like this in Europe. But we in America were not quite so ancient and our first organs were more easily controlled. This old console in St. Gervais, Paris, had thirty-seven registers and stops that pulled out by the yard, it would seem. The pedal clavier was nothing to brag about. Wonder what the tone was like? ("The American Organist")

CHAPTER 8.

MEANS *of* OBTAINING EXPRESSION

THE SWELL BOX

MR. ERNEST M. SKINNER in his book entitled "The Modern Organ" very properly starts his chapter on the Swell Box with the statement that in order to have an effective swell in an organ it is necessary that there be something of real tonal proportions inside the box to sound when the shutters are open. It is perhaps an unfortunate circumstance in connection with organ tone that it has never been possible to increase or diminish the strength of tone from a given set of pipes directly, as is possible with practically any other instrument. The shading of tone in an organ must always be done indirectly, that is, by enclosing the sounding pipes in a box or chamber with shutters (at least in the front and perhaps on top of the chamber) that open and close like the shades of a Venetian blind.

The invention of the first Swell Box is attributed to an Englishman by the name of Abraham Jordan, who, in London in the year 1712, invented a means of enclosing the pipes of one division of the organ in a box with a lid at the top that could be opened or closed by a pedal. This was termed the "Nags-head Swell." It was superseded by a series of shutters placed in the front of the box. Even though this invention was made more than two hundred years ago, it is strange that it was never extended to any other division than the Swell organ for the longer portion of this period. The Swell shutters of almost all organs were made to fall shut by their own weight or by means of a spring. The organist might leave the Swell Box shut or, by means of a catch on the pedal, hitch it full open. Sometimes intermediate catches were provided, but it was at best an awkward means of controlling the shutters. Yet, some English organists still persist in wanting this type of swell pedal on the organs they play.

The introduction of the balanced swell pedal, which is due to Walcker in 1863, has greatly increased the tonal flexibility and expressiveness of the organ. This is the type used exclusively in America at present. The shutters themselves are either actuated by mechanical means directly from the pedal, as was always the case in the tracker organ, or by some kind of pneumatic motor, several forms of which will be described later. With the balanced swell pedal the shutters will remain in any position in which the pedal is placed.

Dr. Audsley, in his "Art of Organ Building," was perhaps the first to urge the greater extension and use of the swell in the organ in a systematic and logical way. He rightly argued, I believe, that the organ when left unenclosed was the only musical instrument whose tones could not be controlled in the matter of shading. He consistently advocated the enclosure of all divisions of the organ in separate chambers, including the Pedal Organ, though perhaps allowing the Principal Diapason on the Great Organ to remain unenclosed.

These ideas seemed quite revolutionary at the time they were advanced, though Hilborne L. Roosevelt, in the large organ in the Auditorium at Chicago, as early as 1892 had placed every division of this important organ under expression except a few ranks of Diapasons on the Great Organ and the Pedal Organ. This was nearly forty years ago. In this matter Roosevelt was more advanced than any of his contemporaries. The past ten years have made it a commonplace for the entire organ to be placed under expression, preferably in at least two chambers. The Great and part of the Pedal are in one chamber, the Swell and the balance of the Pedal in the other, in the case of a two manual organ. The Great and Choir are usually in one chamber and the Swell in another if there are three manuals, with an additional chamber for the Solo organ if a four manual organ. There is frequently some advantage if the layout of the organ will permit, in enclosing the Great Organ separately from the Choir.

We come now to a very disputed point in regard to the extension and use of the Swell in the organ. Such authorities as Mr. Ernest M. Skinner, Mr. Henry Willis and Mr. Emerson L. Richards, and others, still appear to be unalterably opposed to enclosing any of the Diapason section of the Great Organ or in fact any of the Great Organ, thereby rendering the tones of these pipes expressive and flexible along with the other divisions of the organ. Their argument is that a certain amount of "bloom" of tone is lost when these pipes are enclosed. This is undoubtedly true when the organ may be placed, as it usually was formerly, in an open position with ample space and height above and on all sides of the pipes. The modern practice, however, of placing the organ in two or more chambers and allowing it to speak from behind grills more or less open, does not create any such acoustical advantages for the Diapasons, whether there are shutters in front of them or whether they are left speaking directly behind the grills. It is not so important that the Great Organ be enclosed, in a building with fine acoustics, as in one with poorer acoustical advantages.

As a matter of actual fact, the Riverbank Acoustical Laboratories have made tests of the effect of shutters placed in front of the Diapasons that are already standing in a chamber, and their tests show that there is a loss of only about ten per cent of tone with the shutters open, as compared to having no shutters at all, which is an amount scarcely appreciable to the human ear, and a loss that may easily be made up by a little more winding of the Diapason pipes themselves.

It is perhaps a little curious that the chief objections to the complete enclosure of the pipes in the organ come from the organ builders and not from the organists. The ones who actually have to play the organ and are not bound by theories, seem to be fairly unanimous in favor of the entire enclosure. Such great artists as Lynnwood Farnam and Charles Courboin, and many others, principally of the younger generation of organists, are whole-heartedly in favor of rendering the organ completely expressive.

This is particularly advantageous in the case of the small organ, where especially all of the tonal resources must be available for maximum variety and use. In the case of a large Cathedral organ that can be placed in an open position and where there is much resonance in the building, I am inclined to agree with the authorities before mentioned that a large part of the Great Organ can be left unenclosed advantageously. Under ordinary conditions, I am of the strongest belief that the entire organ should be enclosed, and be rendered both flexible and expressive.

The modern practice of placing the pipes in well-constructed chambers with hard reflecting wall surfaces is of the greatest advantage to the tone of the pipes when the shutters are open as compared with the small, cramped, boxes that were formerly employed. These latter were often so cramped and filled with pipe work that it is astonishing any residue of tone found its way into the church.

We come now to the construction of the shutters, which are practically all that need to be considered in the majority of present-day organ installations. Adequate and suitable chambers are usually provided at the time the church is built for the enclosure of the pipe work. There seems to be considerable difference of opinion among the various builders as to the proper thickness of these shutters.

One of our leading and most successful builders has for many years built organs with shutters of a thickness of only one and one-quarter inches. From this limit of minimum thickness, shutters have been built of various thicknesses up to three inches. It has been my experience that little is gained in using shutters more than two and one-quarter inches in thickness. This size is employed by several of our leading builders. It is more important to have the shutters themselves fit tightly at the joints than to have them extraordinarily heavy.

There are some difficulties in having the shutters fit too tightly, as a prolonged damp season will cause them to swell and probably bind. A prolonged dry period will cause them to shrink, and the distance between them become too great to render them properly effective. The Austin Organ Company has very ingeniously overcome these difficulties by making their shutters of sheet metal, mounted on wooden frames. The Kimball Company uses instead of the customary white pine a hard wood such as chestnut, that seems to be less affected by atmospheric changes than white pine and enables them to fit their shutters more closely. To overcome warping and twisting of the shutters, they are usually made of a series of strips of wood glued together with the grain running in reverse directions. This laminated construction overcomes a tendency to warp.

Mr. Robert Hope-Jones went to extremes in the matter of Swell Box construction. He constructed the boxes of brick, cement and other inert and non-porous material and substituted for the felt usually employed at the joints of the shutters his patented sound trap joint. This is simply a series of grooves sawed in the bevelled edge of the shutters as shown in our illustration. He even attempted to make shutters from hollow aluminum castings from which the air had been pumped from the interior of the shutters. This would have made the shutters marvelous non-conductors of sound, as well as being extremely light. They could, therefore, have been opened and closed with great rapidity. Even a very thin vacuum shutter would form a better non-conductor of sound than a brick wall two or three feet in thickness.

This type of shutter never was used by our leading builders, and was found by Hope-Jones himself to be impracticable. Excellent results are being obtained with the varieties of shutters described when they are carefully fitted. There are limits to the extent it is desirable to annihilate the tone of the pipes. Dr. Audsley, in referring to the Hope-Jones type of Swell Box, called it the "tone annihilating swell" and referred to its effect as that of a "bee in a bottle".

There are two major types of mechanism in present day use for the control of the swell shutters. The one employed by the Skinner Organ Company and the Austin Organ Company operates all the shutters of one chamber as a group by means of a trace, as shown in Figure 33, and provides one large motor for moving the whole set.

Both of these builders make use of a very ingenious type of pneumatic motor for this purpose, called the "whiffle-tree" motor. By an examination of Figure 33, it will be seen that very gradual operation of the driving rod is accomplished by the operation of any one of the pneumatics, because of the series of levers that are interposed. This is very important. The very gradual opening of the shutters, particularly in

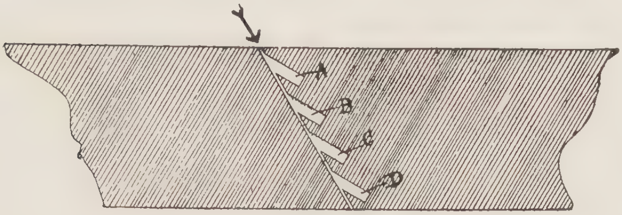


Figure 31.

The "Sound Trap" joint, used by Hope-Jones. The arrow points to the joint through which the sound passes. The theory was that the sound woulld not pass through the joint but become dissipated in the sound trap pockets, A, B, C, D.

the initial stages, is the chief quality that any efficient swell motor should have. The first few stages of opening the shutters must necessarily be very smooth and gradual. After the shutters are open a short distance, they can be moved a greater amount without a corresponding increase and decrease in tone.

The other type of shutter mechanism is that employed by the Kimball, the Wurlitzer and Moller companies, as well as several others. It employs individual small pneumatics for each shutter. In the case of a very large front, two or more shutters may be hooked together to operate on the final stages when all the other shutters are open. Figures 32 and 34 show the individual shutter motor.

With this latter type of swell movement, it is necessary to have two or three of the shutters considerably narrower than the average width, as these individual motors either open the shutters wide or permit them to close. Therefore, the first shutter is permitted to open only a small distance and is very narrow. The next one is permitted to open a greater distance and the shutter is a little wider. After the first two or three stages, the standard width shutters opening the full distance are employed. By this means a very gradual opening of the shutters is possible, rendering an extremely even crescendo and diminuendo with the utmost nicety.

There are arguments in favor of both types of mechanism. Some organists have contended that with the individual shutter control, the tone is more or less localized by issuing from a restricted opening at one end or other of the shutter front, rather than from a series of openings across the entire front as is the case when all the shutters are hooked together and moved at the same time a greater or less extent. I have never been able to observe this disadvantage of individual shutters. It appears to me that when they are properly regulated and designed to do the work with the greatest efficiency, that even greater speed of operation is possible with the individual shutter action than with any form of single large motor operating on an entire shutter front. It is true, however, that the new single motor type that the Austin Organ Company has recently adopted, particularly with the new style of shutter construction, permits an extremely rapid operation of the shades, quite rapid enough for any legitimate requirements. For excessively fast movement of the shades, as is demanded by theater organists, the individual type that the Kimball Company and Wurlitzer Company have brought to a high degree of perfection seems to me to give the best results.

The matter of the efficient and rapid opening and closing of swell shutters is of great importance, and all of our American builders have spent considerable time and effort in perfecting these mechanisms. One of the most serious obstacles to obtaining a fast action is the difficulty of preventing the shutters from slamming when closed too rapidly, even though they are padded with felt.

The Aeolian Company have developed for the next to last stage of closing of the shutters, a very ingenious check which acts more or less as a brake. This permits the shutters to close very rapidly to just within striking distance of each other, and then checks the motion, insuring a quiet closing. The individual shutter action accomplishes this by a pneumatic check which, when properly adjusted, prevents slamming. The adjustment of this check is a rather delicate matter and requires attention occasionally for changes in atmospheric conditions. If not regulated properly, the shutters are likely either to slam or close too slowly.

The Austin Organ Company has recently overcome this difficulty

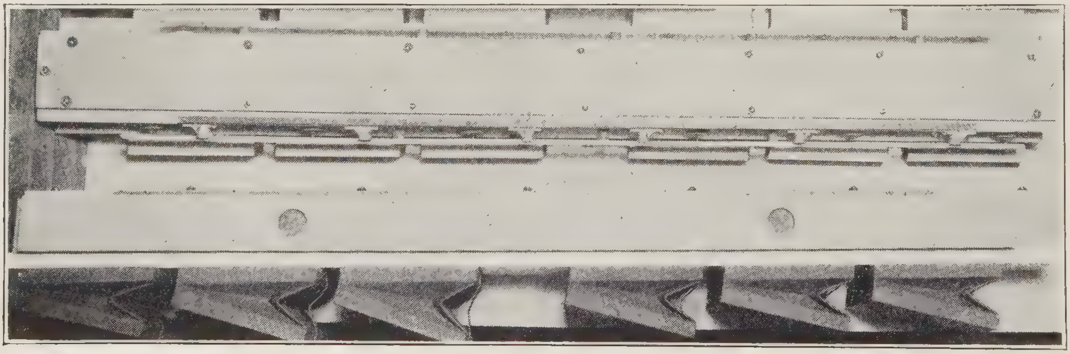


Figure 32.

A series of individual pneumatics for operating the swell shutters of a Moller organ. The pneumatics are operated similarly to that explained for the Kimball pneumatic shown in Figure 34.

entirely with a new form of construction, illustrated in Figure 35, which is as ingenious and clever as are so many other of the Austin inventions. Instead of allowing the shutters actually to close upon each other, thereby creating the possibility of slamming, they have designed the shutters to rotate on their centers in a complete circle. The shutters may be adjusted to open either in or out, whichever is most desirable. A very small clearance is provided so that they may actually pass between each other. Figure 35 illustrates this.

The construction of shutters as shown also compensates for any swelling or shrinking of the wooden portions. The narrow strip at each edge of the shutter is subject to a small amount of swelling and shrinking, according to atmospheric conditions. With the small clearance between the shutters, they might swell sufficiently to cause them to bind. This possibility is compensated by the large six-sided white pine strip into which the center pins are driven and which forms the backbone (so to

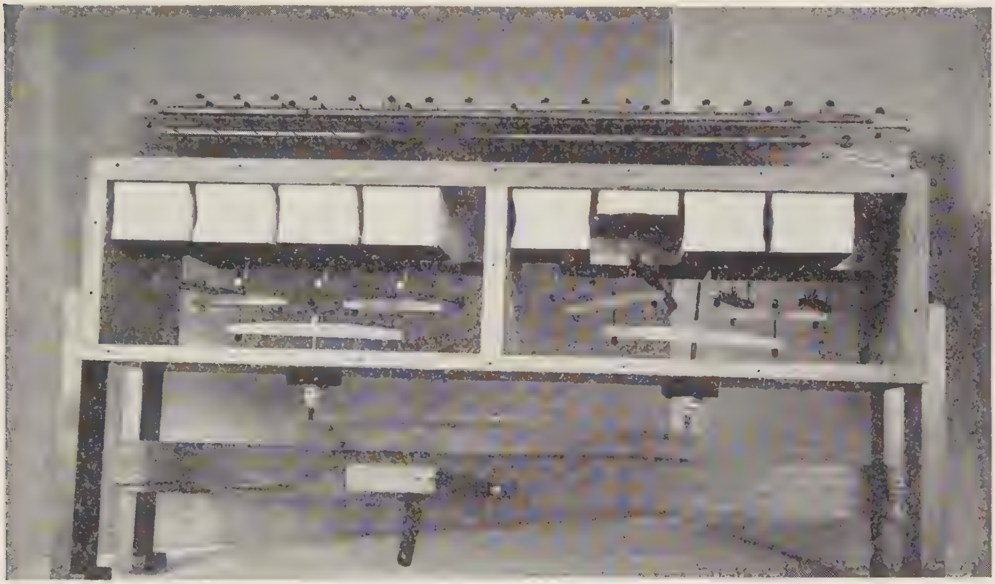


Figure 33.

The Whiffle-tree motor for operating the swell shutters employed by the Skinner Organ Co. A similar motor is now used by the Austin Organ Co. The outer cover of the box has been removed to show the series of square pneumatics. Each pneumatic draws one end of a lever as it collapses. The lever so drawn is connected in turn to a series of other levers, so that the net result of such motion is a very small, but powerful movement of the square shown at the bottom of the photograph, which is mechanically connected to a trace that draws the shutters simultaneously. The mechanism is in effect geared down to produce a gradual opening or closing of the shutters, with absolute control over the motion at all points. The great advantage of this motor is that all the pneumatics will collapse just as quickly as a single one will, thus the shutters may be fully opened or closed just as quickly as they can be moved a small distance. Sforzando and accent effects are thus easily possible.

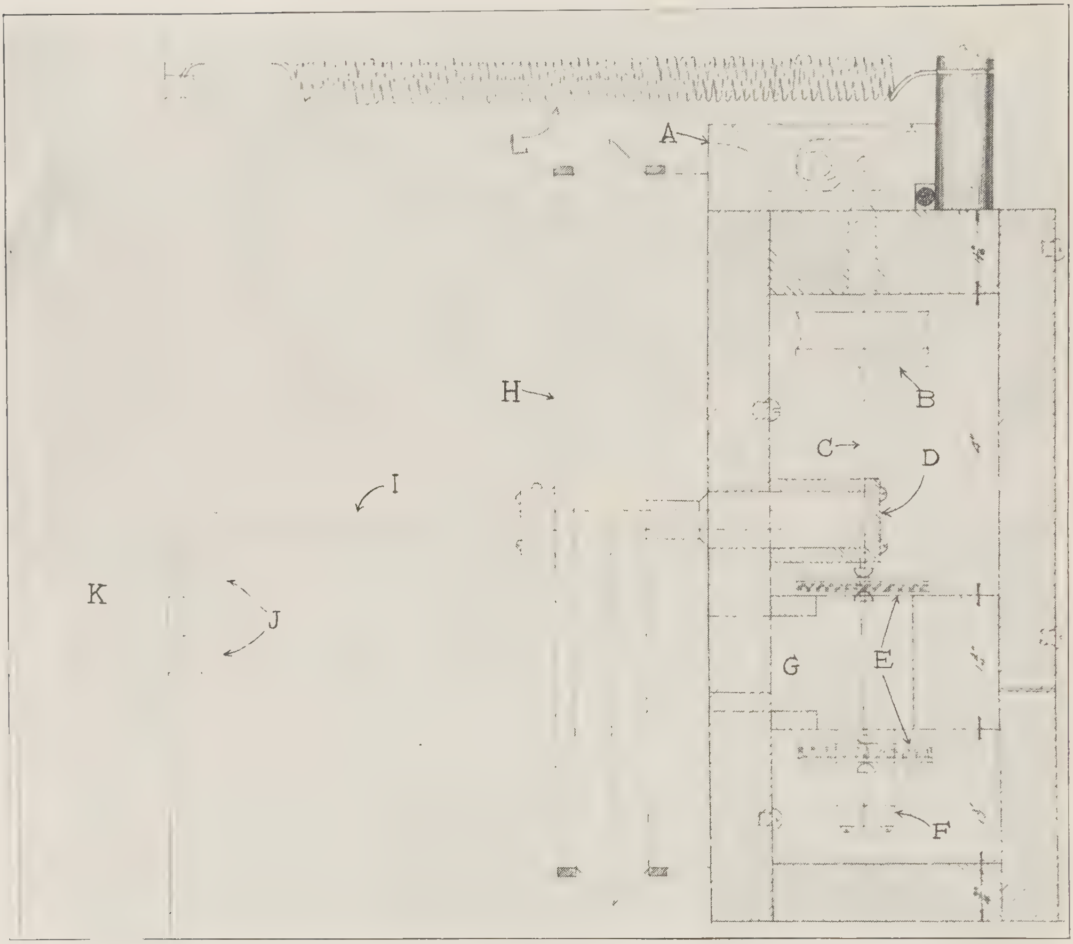


Figure 34.

The Kimball swell shutter pneumatic. K represents a swell shutter, which is drawn closed by the coiled spring L. The shutters therefore close when the wind is out of the organ, the contrary of the usual practise. The organ is kept much cleaner by this arrangement. H is the square pneumatic, which will produce twice as much power from a given size and pressure as the hinged pneumatic, a distinct advantage. It connects with the shutter by the rod I which is pivoted at J. When the magnet A is energized, the auxiliary pneumatic B is deflated, drawing with it the double valve E, allowing the compressed air from upper chamber to pass through the port G into the pneumatic H. This inflates the pneumatic which pushes open the shutter against the action of the spring L. It should be noted that spring and pneumatic act on opposite edges of the shutter. When the magnet is not energized, the pneumatic is allowed to exhaust into the atmosphere, as the double acting valve is in the position shown in the drawing. The spring L can then act and close the shutter and pneumatic at the same time. The exact size of the pneumatic, spring, air ports, etc. are all of great importance to the successful operation of this shutter mechanism. Such matters have been determined only after careful tests, and the results have proved adequate.

speak) of the shutter. The sheet metal that is attached to the end strip and this center strip naturally will not be affected by atmospheric changes. In case of swelling of the wooden parts, the swelling of the center member will tend to draw the narrow wooden strip at the edge closer to the center and thus compensate for its swelling. It will act in the opposite way when the wood shrinks.

This has been tested by soaking the shutters in a tank of water for some time, after which it was found that they functioned perfectly. This seems to be a real improvement in shutter construction. The advantage, of course, lies in being able to adjust the motor to close the shutters with extreme rapidity without the possibility of slamming.

As it is most important for an effective swell to have a tight fitting shutter front, which is obviously difficult to maintain at all times, it appears that some rather inert hard wood might better be employed. Chestnut, for example, is not so much affected by atmospheric changes. Such wood enables the shutters to be fitted rather more closely. This matter is distinctly worth more consideration than some of our builders have given it.

Nothing has been said previously about the construction of Swell Boxes, should these be necessary. They sometimes are when the organ is placed in the open, instead of in its own chambers. The latter automatically provide the best type of Swell Box, especially when the walls are lined with hard material capable of reflecting sound to advantage. The high pressures employed, particularly on the Reeds of the modern organ, make it imperative that when Swell Boxes are constructed they be of considerably greater thickness and more resistant to the passage of sound than was formerly necessary to make a reasonably effective swell for the organ.

The Austin Organ Company make use of two thicknesses of half-inch yellow pine with a space between stuffed with sawdust and two thicknesses of building paper, making the entire thickness of the walls close to three inches. The yellow pine outer surfaces, when well varnished, make a hard and excellent reflecting surface for the tone, and the sawdust makes a very good sound insulator.

Swell Boxes are now frequently built with various forms of wall board that are on the market, panelled in thick wooden frames. This makes a reasonably good type of Swell Box and when interlined with deadening material is very satisfactory.

The matter of Swell Boxes is becoming of less importance in American organ building, as the majority of installations are in chambers. Some builders now even make an extra charge when they have to provide Swell Boxes, considering that normally all they need to provide is the shutter front.

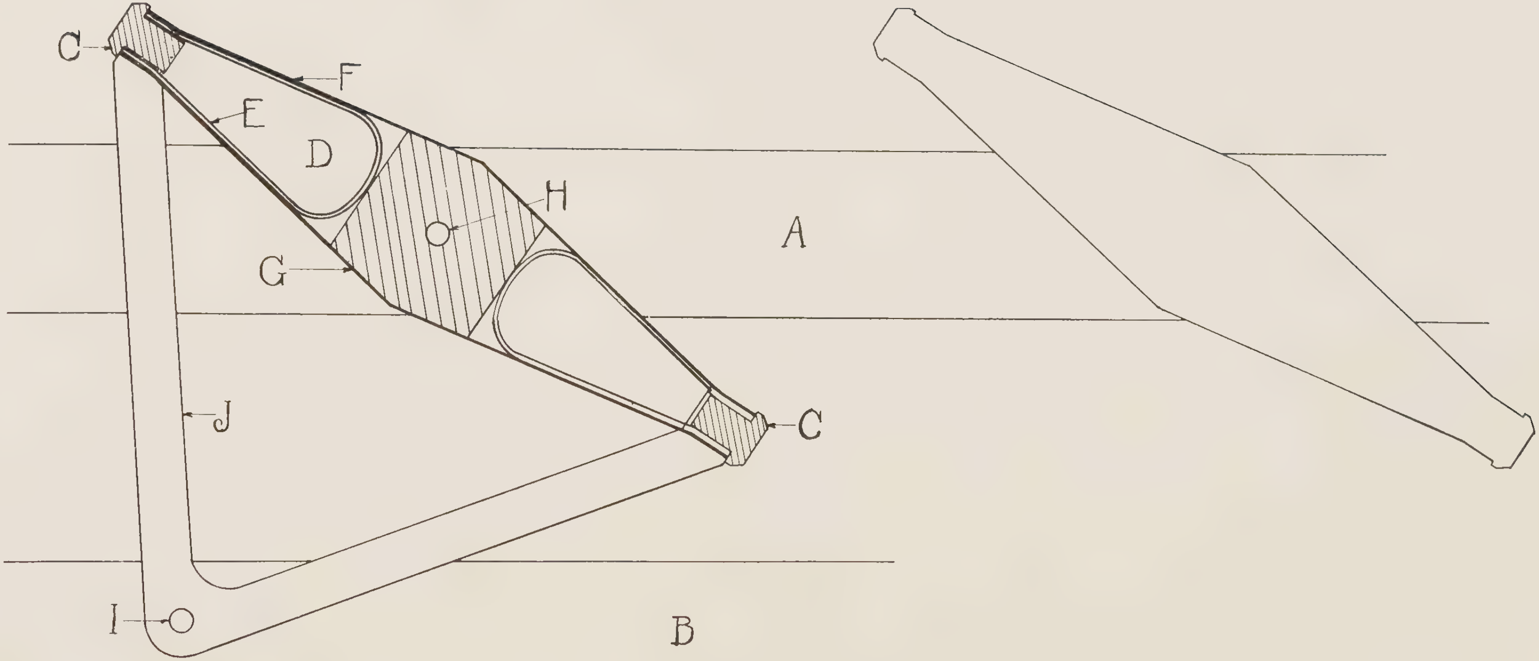


Figure 35.

Sectional view of the new Austin Swell Shutter. A is the frame work of the shutter front, in which the centre pin of the shutter H fits. The six-sided piece of pine, G, forms the backbone of the shutter. The narrow end strips CC are made of hard wood, and are joined to the centre strip by means of steel plates, F. Heavy tar paper lines the interior of the shutters at E. The series of shutters for the entire front is moved simultaneously by means of a trace that is attached at I, to the bracket, J.

MEANS OF OBTAINING EXPRESSION

ADVISABILITY OF ENCLOSING PIPES IN TWO OR MORE BOXES ON SAME DIVISION

In connection with the use of the Swell in the organ, Dr. Audsley wrote voluminously in his volumes, in favor of enclosing each of the various divisions of the organ in two or more separate "expression chambers", to use his terminology. The idea was that on any given manual it would be possible to obtain from its tonal resources what he termed "dual" expression. That is, a portion of the tonal forces are placed in one chamber and the balance in another, thereby making it possible to secure a crescendo on the Flutes and Diapasons, for example, with a diminuendo on the Strings and Reeds, if this is the way the tonal forces happen to be divided.

This matter appeared to Dr. Audsley to be one of the greatest importance, and he spent an endless amount of effort in trying to persuade organists and builders of the advantage of this division of the tonal resources of the organ. It has always seemed to me he was laboring under a misapprehension, borne no doubt in the days of the tracker organ when the coupling of one manual to another was something of a disadvantage as it doubled the weight of the touch and was consequently avoided unless absolutely necessary. Therefore, he stresses what he considers the vast importance of having dual expression on a single manual without resort to coupling. It is always possible to accomplish the same result in any modern three manual organ by coupling the Swell to the Choir keyboard, rendering stops in use on the Swell keyboard instantly available in any combination desired with those of the Choir keyboard. As the stops of the Swell and those of the Choir are nearly always enclosed in separate boxes, dual expression is readily accomplished with even greater variety of tonal resources available than would be possible on any one keyboard.

Dr. Audsley's objection to this seemed to be that it used the tonal forces of two manuals to accomplish what he thought ought to be done with one manual. But all our organs with any pretensions to completeness have at least three or four manuals, and even when the Swell and Choir are coupled together there is also available one or more manuals for additional solo effects, with individual expression on the uncoupled manual. It therefore, seems to me that rather than limiting his means of expression, the organist who couples the Swell to the Choir, as in the case of the example under consideration, is actually making a greater use of the resources of the organ.

I have designed various organs with stops available on two or more divisions, in which case the same manual may have stops enclosed in

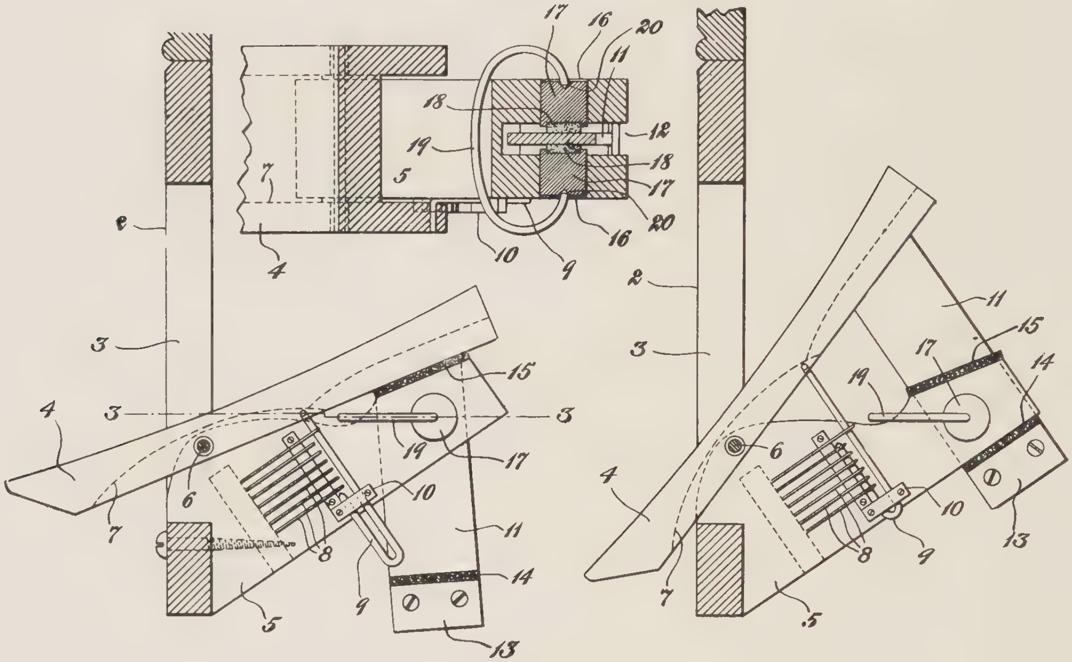


Figure 36.

The Austin expression pedal. 8 represents the series of contacts which are progressively made as the pedal is closed by the large round wire 9 being drawn underneath the contacts. The pedal shown on the left is wide open with no contacts being made, while at the right, the pedal is entirely closed with all contacts made. The tension on the pedal is regulated by the peculiar shaped spring 19, shown more clearly in upper drawing. As in the case of key or stop action contacts, the expression pedal contacts close circuits leading to the magnets on the motor that operates the shutters.

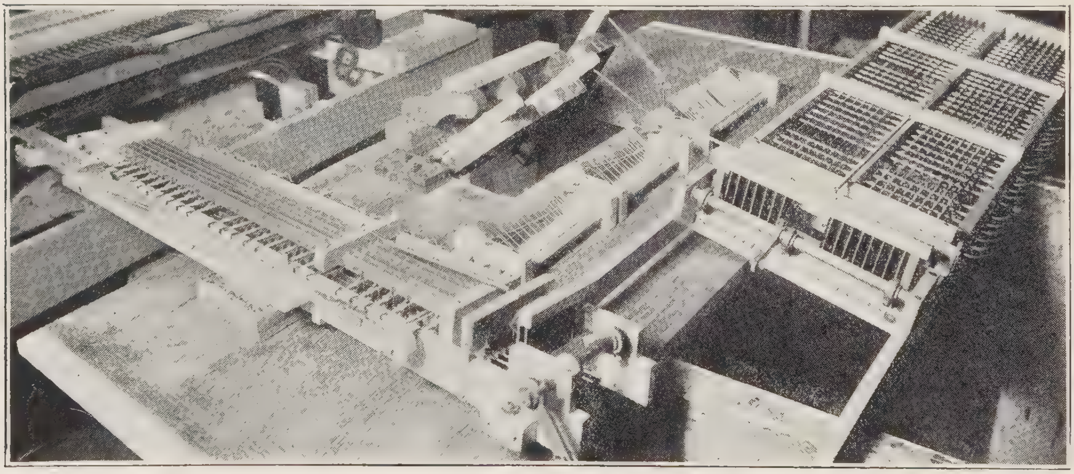


Figure 37.

The Moller expression pedals and crescendo pedal, are shown in the center of the photograph. In this case the pedal rotates a roller or cylinder with a contact strip running diagonally across the face that will progressively make or break contacts as the cylinder is rotated by the pedal.

two or more Swell Boxes, partly in accordance with Dr. Audsley's recommendations. This I find to be a source of annoyance and confusion to the average organist rather than a help. I can see no gain in such complications. The modern organ unquestionably offers many more possibilities for expression and nuance than most of our organists are capable of employing. It is more important that organists become complete masters of the latent possibilities of the present day organ than that additional complications be added. The present resources should first be exhausted. I do not mean to appear reactionary and adverse to welcoming any improvement in organ design. There seems to be no real advantage in Dr. Audsley's system. I have discussed the matter with nearly all our leading players, and they are not in favor of it. Undoubtedly if any of these organists wanted such a system, it would require little, if any more, expense to provide that system of enclosure; particularly now that duplex chests can be economically built by nearly all of our builders so that a two manual organ, for example, completely duplexed on both manuals might with great ease have part of its tonal forces enclosed in one chamber and the balance in another.

As a matter of fact this is exactly what the Skinner Organ Company have done in some of their residence organ installations and with very good effect. This was done more for the purpose of the automatic player than from the standpoint of designing the organ to be more efficient for the organist. The church and concert organist is accustomed to having all the pipes commanded by one manual in one Swell Box. It is annoying and confusing to find them in two or more. All the advantages of dual expression are possible with coupling two or more manuals together. Why complicate matters? Of course, it is really no argument to say that something is not what the organist is used to. Few of us like to adjust ourselves to new conditions. But, if we hadn't, we would still be playing tracker organs with one Swell and that operated by a hitch-down pedal. When changes are a real improvement and assistance to artistic organ playing by all means let us have them.

When there are several expression pedals controlling a number of separate Swell Boxes, their order from left to right becomes of some importance. Two expression pedals may be operated conveniently with one foot. It is difficult with more than two. A switch or series of switches is frequently furnished by builders in such cases, that makes one of the pedals a "master" pedal, which operates all the shutters of the entire organ from one pedal. This is a convenience, but like the crescendo pedal it is liable to abuse and inartistic use by incompetent players. I have known a much heralded foreign recitalist to play an entire program on a large organ with five independent Swell Boxes, with all the expression pedals attached to the one Master pedal, so that all the subtle effects possible in the organ by means of the gradual opening of one box, and closing of another, were completely ignored and wasted. Once more this case proves my contention that many more means of expression are available than some organists are willing (or able) to make use of.

The order from left to right of the expression pedals, which is tending to become standard for any three expression pedals is: Choir, Swell, Solo. If there is a separately enclosed Great, that pedal should be to the left of the Choir pedal.

This order, from left to right of the pedals, is not yet standard for all organs. Some organists find a different arrangement more convenient, or at least are used to a certain order, which means the same thing.

To overcome this difficulty, the Kimball Company have furnished a device which enables the organist instantly to change the position of any expression pedal to left or right, or place all the expression boxes under the control of one or more pedals, in any possible arrangement or order he can desire. When there are three or more expression pedals, this device is most useful, especially where the organ is likely to be played by many visiting organists. Each organist can then set the sequence of the expression levers in accordance with his fancy. It is probably the best practise to place the Swell expression pedal immediately above a point between second E and F on the pedal board. The other pedals will then take their position from this pedal.

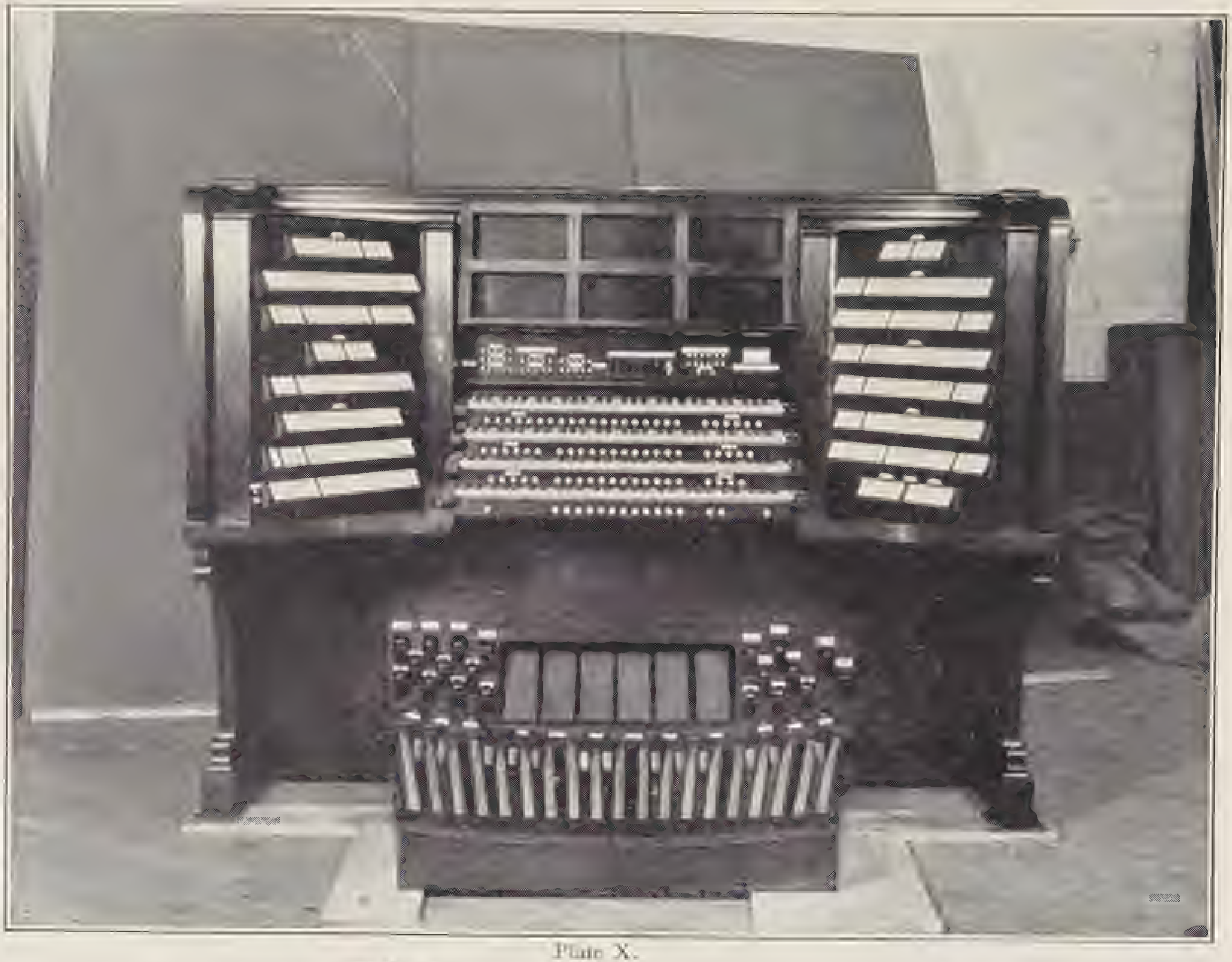


Plate X.

Console of the Pierre S. du Pont Organ. Aeolian Company, builders. Rocking tablets in side jambs are used, similar to the coupler tablets employed in the English type of console. This is the latest designed console of the Aeolian Company.

CHAPTER 9.

THE TREMULANT

IT appears that many of us have gone a long way in our estimate of the value of the Tremulant from the day when Sir John Stainer in his treatise on the organ described that device as "a mechanical contrivance for causing a regularly recurring disturbance in the wind supply." Opinions on this matter are still varied and there seems to be a permanent disagreement between the Purists and the Sentimentalists in regard to the use of the Tremulant. Twenty-five years ago, Mr. James Wedgwood, in his "Dictionary of Organ Stops," stated that "contrary to the accepted precedent," he was not "reiterating the staple stock-in-trade arguments against Celestes, Tremulants, and Vox Humana." The reason he gives is that he is "honest enough to confess that when used with due moderation he finds nothing objectionable in such effects." This statement might be regarded as somewhat negative, but still more friendly toward the Tremulant than Sir John Stainer's.

The modern view of the Tremulant as held by some of the finest organists (at least in America), for example Messrs. Lynnwood Farnam, Charles Courboin, and Charles Heinroth, is that the Tremulant is a most useful device, and one which they frequently employ. I have known one of our finest organists to play an entire recital with all the Tremulants of the organ going. This seems to be carrying the use of the Tremulant to excess, but a moderate use is not objectionable, as Mr. Wedgwood states, but of the very greatest value in imparting a sympathetic quality to the tone, particularly to Flutes, Solo Reeds, and Strings.

Mr. Harold Schwab, in a recent very interesting article on the Tremulant in the "American Organist," states that "Every discussion of this very necessary device leads sooner or later to a comparison between the effect it has upon organ tone and on the tone of the various orchestral instruments, the strings of the orchestra being the example most often used.

"A vibrating effect may be produced in a tone by doing one or both of two different things. First, the tone may be caused to waver in pitch about the point intended to be heard as the definite pitch. Secondly, the tone may increase and decrease in intensity, the pitch remaining constant. Let it be noticed that the usual organ Tremulant produces the latter result. Only when the device is adjusted so that an extreme oscillation is produced is there any perceptible waver in pitch."

The most common use of the Tremulant, of course, is with the Vox

Humana stop. It is a fact that of all of the instruments of music, none produces a more pleasingly vibrant tone than a fine human voice. This vibrant quality is the chief attraction in most stringed instruments. Mr. Schwab states, "The vibrato effect of a singer's voice is one that can scarcely be trained into the voice by direct methods, though in many cases an excessive tremolo must be trained out by any methods that are available." The vibrato proper occurs in some singers naturally, and in others as a consequence of vibrant emotion. Some singers may deny this but will not deny that a voice like Caruso's had a marvelous natural vibrato. Obviously, a tremolo in a voice that includes oscillation in pitch, as well as intensity, is most undesirable. Such a voice, which one of our musical critics described as having "a generous vibrato that included the two adjacent semitones," is by no means the ideal.

On the other hand, a voice without any vibrato, if there is such a voice, is impossibly crude and expressionless no matter how good the actual tone color may be. Yet, that is the vocal counterpart to the organ tone without the use of the Tremulant. Wind instrument players in the orchestra, outside of Jazz orchestras, do not cultivate an intentional vibrato. It comes as a natural result of proper playing, and sometimes from emotional tension.

The overdone tremolo heard in the usual theater organ, especially in connection with the Vox Humana and big Solo Flutes, has obviously no connection with serious music. The tone of the violin is particularly hard and unsympathetic when played without any suspicion of vibrato, though this too can be overdone. The great violin teacher, Leopold Auer, used frequently to tell his overly sentimental pupils, "don't viber." When the vibrato is wisely used, it causes string tone to be perhaps the most eloquent produced by any instrument other than the human voice. When entirely without the vibrato, string tone is extremely tiresome.

The one real difficulty in giving to the tone of the organ a tremolo that will correspond to the effect of the vibrato in vocal or wind instrument tones and those of the strings is, that the organ tremolo must operate at a constant rate of speed and with a never varying amplitude of oscillation, whereas the other instruments respond instantly to the slightest shading and emotional intensity, so necessary to artistic effect.

I believe some builders have already worked on the problem of causing the Tremulant to respond with varying intensity and speed in accordance with the pressure of the finger upon the key. It has even been attempted to produce a tremolo from the keys by the very indirect method of connecting the swell shutter mechanism to be operated by the manual keys themselves. If the shutters respond rapidly enough, they may be made to partially open and close as the finger exerts greater or less pressure on the key. By this means the organist is able to produce the exact intensity and speed of tremolo he desires, theoretically. As a practical matter it has never been possible to make swell shutters respond so quickly and instantly as is required for this use of them. But the idea has possibilities and may very likely prove one means of obtaining the most desirable form of organ tremolo for expressive passages.

Undoubtedly the chief criticism of the well adjusted organ Tremulant at present is, as Mr. Schwab so ably states in his article, "that it is unvariable and thereby becomes as monotonous when used for long periods as the constant use of the same pattern of crescendo would be." I quite agree also with Mr. Schwab in his statement "that generally given an organ with all voices represented, the Tremulant is not only unnecessary but bad in large combinations." This use of the Tremulant for massed effects is better confined to masses of String tone or bright Chorus Reed tone than it is to Diapasons or big Flutes, though the latter use is almost invariably indulged in by the theater organist.

Another type of vibrato effect has been liberally introduced into the modern organ. Ranks of pipes of various qualities and strengths of tone are employed, which are tuned slightly sharp or flat with another rank which is tuned perfectly in unison. The sharp or flat rank usually is made of the same scale and quality as the unison rank with which it is associated.

The originator of this method of adding "warmth" to organ String tone appears to have been Cavaille-Coll, the eminent French organ builder, who some seventy-five years ago, introduced the Voix Celeste, for the first time, and later in nearly all of his organs. The large present day organ has frequently as many as six ranks of the Celeste type. The Celeste effect has been extended to light toned metal Flutes, such as the Spitz Flute or small scaled Concert Flute, also to Dulciana pipes and all strengths and qualities of String tone. Another Celeste is a hybrid tone of the Gemshorn type, termed by Mr. Skinner "Kleine Erzähler," which gives a particularly lovely subtle effect when two ranks are provided, one tuned slightly sharp. The purpose of all of these Celestes is to make the tone of the organ more "warm" and vibrant. The softer Celestes may, without detriment, be used with the full organ, but the more pungent String tone Celestes should never be used for ensemble purposes. In fact, keen Strings of any sort are extremely injurious to a proper organ ensemble and have an uncanny way of asserting themselves even though the tone with which they are associated may have many times the power of the Strings themselves.

So far from dismissing the matter of the Tremulant and the more

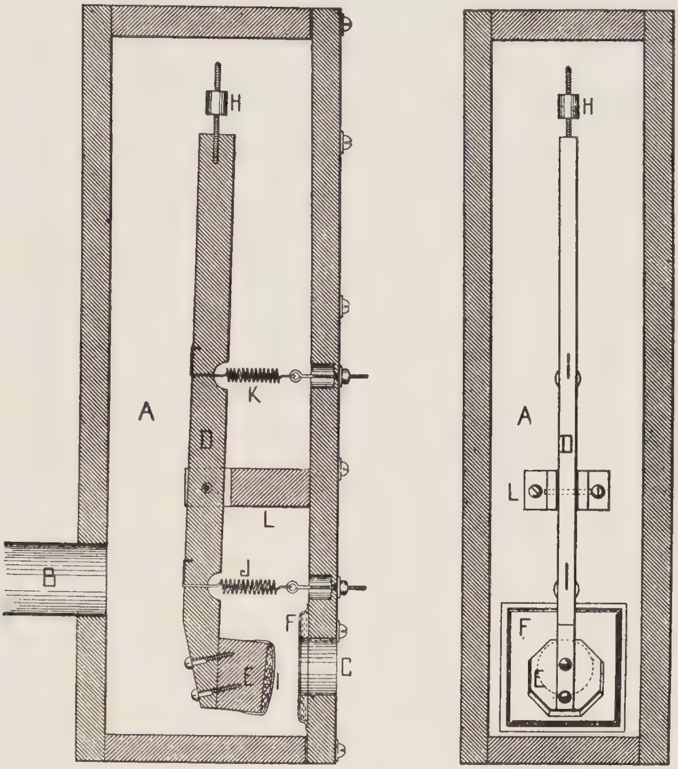


Figure 38.
Cross sectional, and front views of the valve or beater tremulant. (From G. A. Audsley, "The Art of Organ Building.")

individual means of producing a vibrato on certain stops by tuning certain ranks sharp or flat, with the cursory statement of Sir John Stainer, quoted above, I believe the modern view of these means of obtaining warmth of tone and relieving monotony is that they are greatly appreciated. They are very valuable to the artistic organist and a liberal supply of both Tremulants and Celestes should be available on an organ with any pretensions to completeness.

It is not common to place a Tremulant on the Great Organ as this department primarily contains the Diapasons which are least in need of its aid. However, in most three manual organs of smaller size, the Great Organ nearly always contains the principal large scaled Flute with which a proper tremolo is most useful and certainly a Tremulant is justified on the Great Organ if used for no other purpose than that. Please note it should *not* be adjusted for a violent vibrato to imitate the sobbing theater Flute.

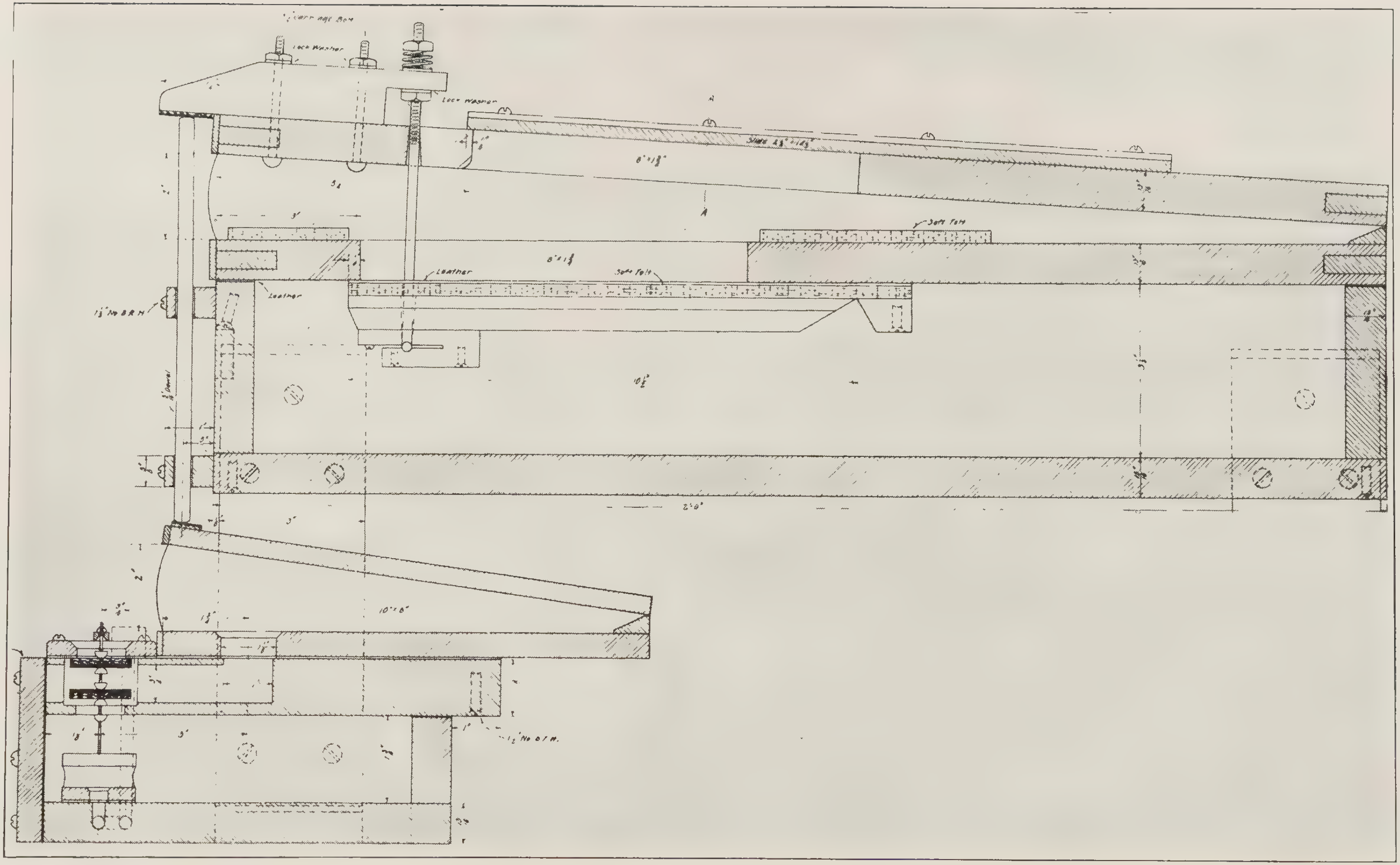


Figure 39.

The tremulant used by the Kimball Co. This is also the general type employed by many other builders. The stop action that starts the device into operation exhausts the pneumatic shown at the lower left, which allows the dowel to drop and the tremulant bellows to fall, admitting wind through the pallet. This starts the tremulant bellows to vibrating as explained in the text.

TREMULANT

CONSTRUCTION AND OPERATION OF TREMULANTS

There are two common types of Tremulant in use in organs of the present day. In either case they are best placed at a considerable distance from the organ chamber, preferably in another room, which may usually be done conveniently. All that is required is a galvanized iron or zinc conductor from the windchest or regulator, ordinarily of three inch diameter, and two wires run to the magnet that opens the valve that permits the compressed air to escape into the Tremulant itself.

Figure 38 shows the "beater" type of Tremulant, which consists simply of a pivoted rod with a weight at one end and a round disc of wood at the opposite end, padded with felt and leather. This disc is so placed as to close the hole which permits the wind to escape out of the box when in the "closed" position.

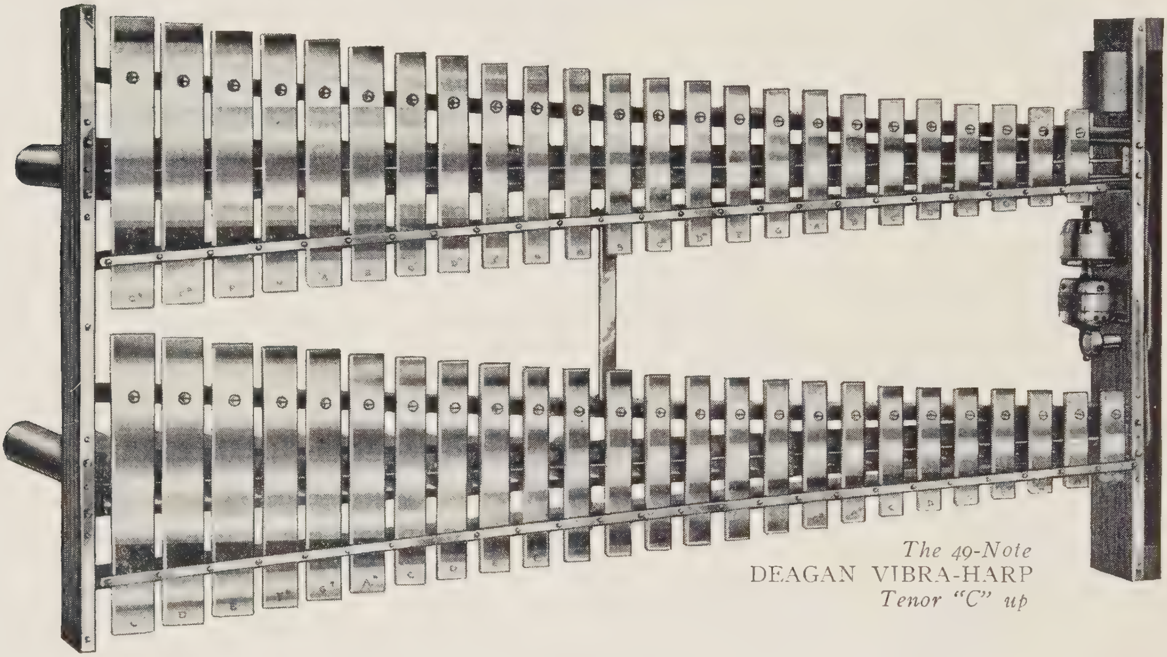
There is a small coil spring which causes the beater to remain in the open position, normally. When the wind is allowed to enter the beater chamber, it immediately starts to rush out the opening and causes the beater to close against the opening, thereby momentarily shutting off the escape of wind and allowing the spring to return the beater to its normal position. By carefully adjusting the balance between the counter-weight, the spring and the length of travel that the beater is permitted, the beater may be caused to vibrate at one of the most desirable periods (either fast or slow, with large or small amplitude) that is required for the best effect to be produced on the pipes.

The form of Tremulant shown in Figure 39 is very similar in principle to the beater type, except that the air is permitted to enter a small bellows which in turn is raised by the compressed air entering, thereby shutting off its escape by closing the valve at the top of the bellows momentarily. This may also be regulated to any speed or amplitude of beat.

There are several factors that assist in securing a successful Tremulant. The size of the Tremulant and the amount of air that is permitted to escape periodically must be governed by the size of the windchest, (a very large chest obviously requiring a larger Tremulant to produce the proper effect than a smaller one). A compromise also must be reached between obtaining perfectly steady wind (which is most successfully done by the use of springs alone on the reservoirs without any weights) and a certain elasticity that the reservoir must have in order to be properly affected by the Tremulant. Therefore, it is found necessary in most cases to have a certain amount of weight on the reservoir as well as springs in order to make the Tremulant effective. The reason for this is made clear in our chapter on The Wind Supply of the Organ.

Some builders have installed fast and slow Tremulants on the same manual. This is a step in the direction of varying the speed of the vibrato to suit the needs of various classes of stops. String tones frequently sound better with a faster vibrato than Flutes or Solo Reeds, so that two Tremulants to a division permit of this. With one Tremulant the speed is adjusted to a rate that is most generally useful.

Another special form of Tremulant is described in our chapter on The Universal Air Chest.



The 49-Note
DEAGAN VIBRA-HARP
Tenor "C" up

Figure 40.

The more usual organ Harp or Celesta looks precisely like this, before the pneumatic padded hammers have been installed over the bars. The Kohler-Liebich Co. of Chicago also specialize in all types of organ percussions, though the Vibra-Harp is exclusive with J. C. Deagan of Chicago.

CHAPTER 10.

PERCUSSION TONE *in the* ORGAN

THE past fifteen years have greatly increased the popularity of the organ percussions with many American organists and builders and especially the public. Harp and Chimes in particular have come to be regarded as practically indispensable to every organ. The "Trilogy" Harp, Chimes and Vox Humana are the three stops generally desired first by the average music committee of a church about to purchase an organ. It is interesting to note that this keen desire for these three effects has not yet reached England. There, Vox Humanas are seldom seen except in large instruments; and I suspect the number of Harps and Chimes installed in church organs in England could be counted at present on the fingers of two hands. The theater organ has served to popularize percussion tone, while the Vox Humana we have had with us, lo these many years before the rise of the theater organ.

There is not the slightest wish on my part to disparage the introduction of these voices in the church organ. Harp and Chimes not only have a legitimate place in such an instrument but by their characteristic and easily recognized qualities of tone supply variety and interest to both layman and organist.

Organ Chimes consist of a series of tubes, made chiefly of brass and of some alloy, kept secret by the manufacturer. The tubes vary in length from about six feet for the lowest note to about three feet for the highest. The diameters vary ordinarily, from 3/4″ to 1 1/2″. The Chimes are frequently made of the same diameter throughout their compass, though a graduated scale is thought to be better, and is more logical.

J. C. Deagan, Inc. and Kohler-Liebich Company of Chicago, as well as R. H. Mayland & Son of New York, specialize in organ percussions. Organ builders generally purchase the tubes and bars with resonators from one of these firms and make their own action parts.

Twenty notes, from A below middle C to second E above, is a usual compass for the Chimes. A two octave range from G below to second G above or twenty five notes is also frequently employed. The former is usually quite sufficient. The appearance of the Chime tubes is similar to that of those used in the orchestra. It is necessary that they be supported by means of a string of cat gut or a stout cord and that they hang freely. Some tubes are open at the bottom while others are plugged. They are always closed at the top. For appearance, the tubes are nickel-plated and polished.

The action which strikes the Chime tubes consists of a suitable

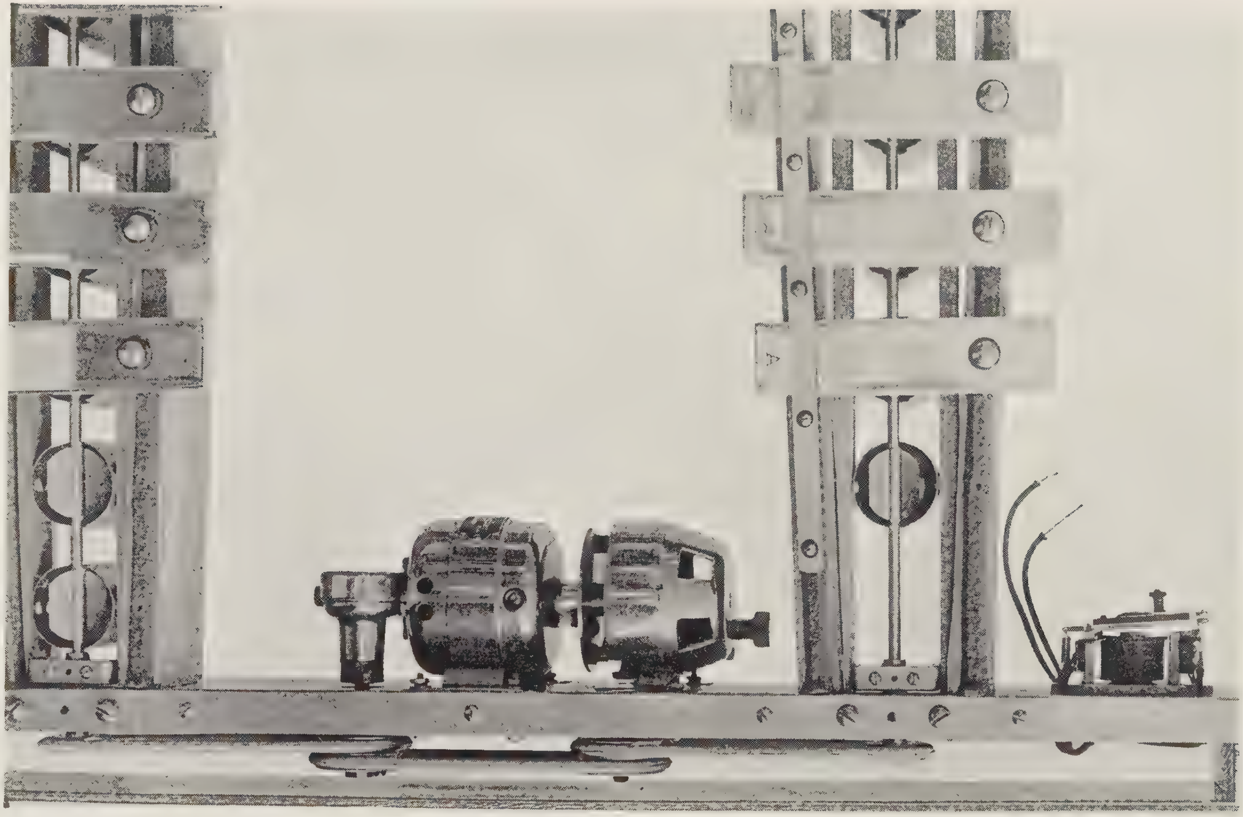


Figure 41.

The Vibra Harp

Three of the bars have been removed to show the metal discs which rotate in the tops of the resonators. The small electric motor, rotates the discs by means of rubber belts. The speed of rotation may be adjusted to any taste.

hammer that is forced against the tube by a pneumatic. The pneumatic is a hinged bellows about 2″ wide by 12″ long, into which air is admitted by a double-acting valve similar to that described and pictured for the windchest primary valve; for example, Figure 79 shows such a valve clearly.

All organ percussion actions, whether for Harp, Chimes, Xylophone or any other, must follow the same principle that applies to the piano action. That is, the hammer must not remain touching the string, tube or bar, even if the key is sustained. In that case the vibrations of the tone so created by the impact of the hammer would be damped. In the case of the piano action, the hammer slips off the jack that pushes it against the piano wire, just before it touches the wire. The momentum of the hammer, causes it to strike, and immediately rebound a short distance so that the tone is not damped. Both Chime and Harp actions have been successfully made with a piano action actuated by power pneumatics, by the Kimball Company. The Chime action hammers are usually so arranged that a portion of the hammer stem will spring forward sufficiently to permit the hammer to strike the Chimes, and immediately spring back a short distance, because the motion of the main portion of the hammer stem is checked before the hammer touches the Chimes.

Sometimes dampers are applied to the Chimes. In other cases the motion of the hammers can be varied, permitting of loud or soft effects, similar to the soft pedal in an upright pianoforte.

Dampers are not really necessary on Chimes, nor on many organ Harps.

The usual Harp compass is 49 notes from Tenor C to C4, though some builders use a compass of GG to G3, 49 notes. The lowest octave of the keyboard frequently is wired into the octave above on the Harp, so that all 61 notes will be capable of sounding, though the bottom octave in this case will merely duplicate the octave above.

The Harp bars are frequently made of steel and are carefully graduated and adjusted for pitch and quality. The tone of the bars themselves is very weak, and must be augmented by means of resonators placed immediately beneath the bars, of suitable length and diameter, to produce the greatest resonance from the tone of the bars. The resonators resemble baking powder cans of various sizes.

The Deagan Company have recently developed a new type of Harp known as the *Vibra-Harp,* a detail of which is shown in Figure 41. In this case the bars are made of aluminum and the tone sustains for a much longer period than with steel bars. Dampers are not necessary with the latter but are required with aluminum bars. A series

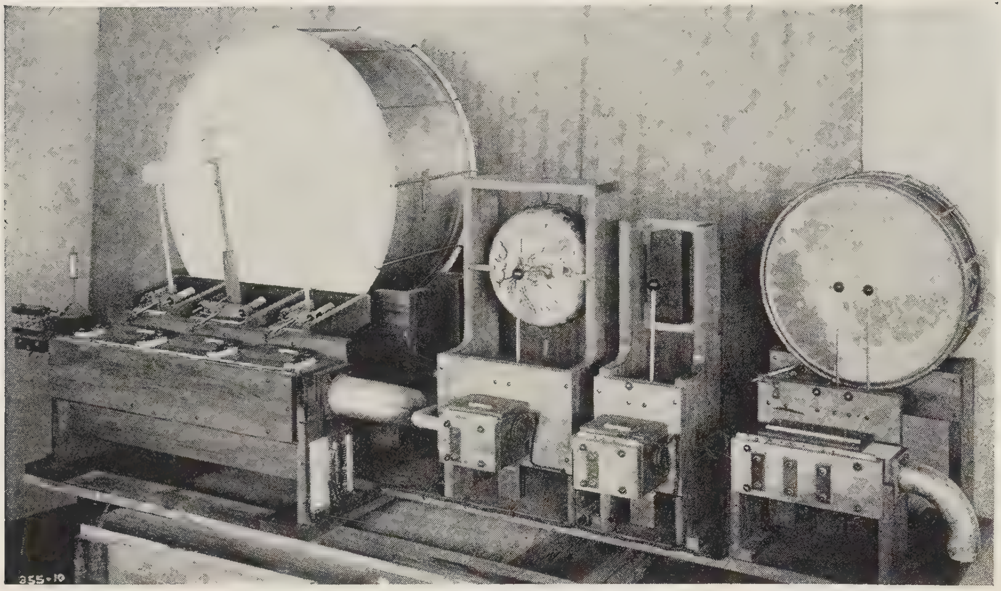


Figure 42.

Some of the Percussions usually found in theater organs. These include the Bass Drum, Snare Drum, Chinese Block and Tambourine, Triangle, Steamboat Whistle, Auto Horn, Sand Paper, Airplane effect, etc. The superintendent of the Kimball organ factory refers to the Drums and Traps as the "Toy Counter."

of metal discs, or dampers are caused to rotate by an electric motor, within the tops of the resonators, at a suitable rate of speed, in the case of the Vibra-Harp, to impart a pleasing undulation or tremolo to the tone. The purpose of the rotating discs, is to partially shut off and then open the tops of the resonators, thereby varying the resonating effect. When the openings of the resonators are nearly closed by the discs, the resulting tone is softer. The power of the tone can thereby be pleasingly varied at regular intervals, producing a very lovely effect. The discs need not rotate, and in this case they will stop where the resonators produce their greatest effect, and the Harp may be used as an ordinary organ Harp. A stop key or switch can control the action of the Vibra mechanism very easily.

Such a Harp is ideal in residence and theater organs, giving an entirely new color in the organ. I believe there are uses for it even in a church organ. The installations I have seen have been very successful.

Other organ percussions, such as Glockenspiel, where the steel bars are struck with hard hammers, the wooden Marimba, Xylophone and so forth are all built along similar lines to the regular organ Harp or Celesta. They may have a reiterating mechanism, for more accurate orchestral effect.

The "Traps" used in the theater organ, including Bass Drum, Snare Drum, Tambourine, Triangle and all manner of imitative effects, are produced by the instruments themselves being struck by some form of pneumatic hammer, instead of by hand. They have proved themselves most useful for the purpose intended. Figure 43 illustrates a few of the more common "Traps".

It should be noted that in any percussion instrument, the exact shape and size as well as material of which the hammers are made have an important effect on the tone produced. Nearly every one is familiar with the great difference in tone produced by piano hammers of various qualities and conditions of felt. The same is true of organ percussion hammers, and the percussion manufacturers are careful to furnish hammers of well suited material and proper size for producing tone of greatest musical value.

Harp hammers must graduate in size and degree of hardness, similarly to piano hammers, to produce the best results.

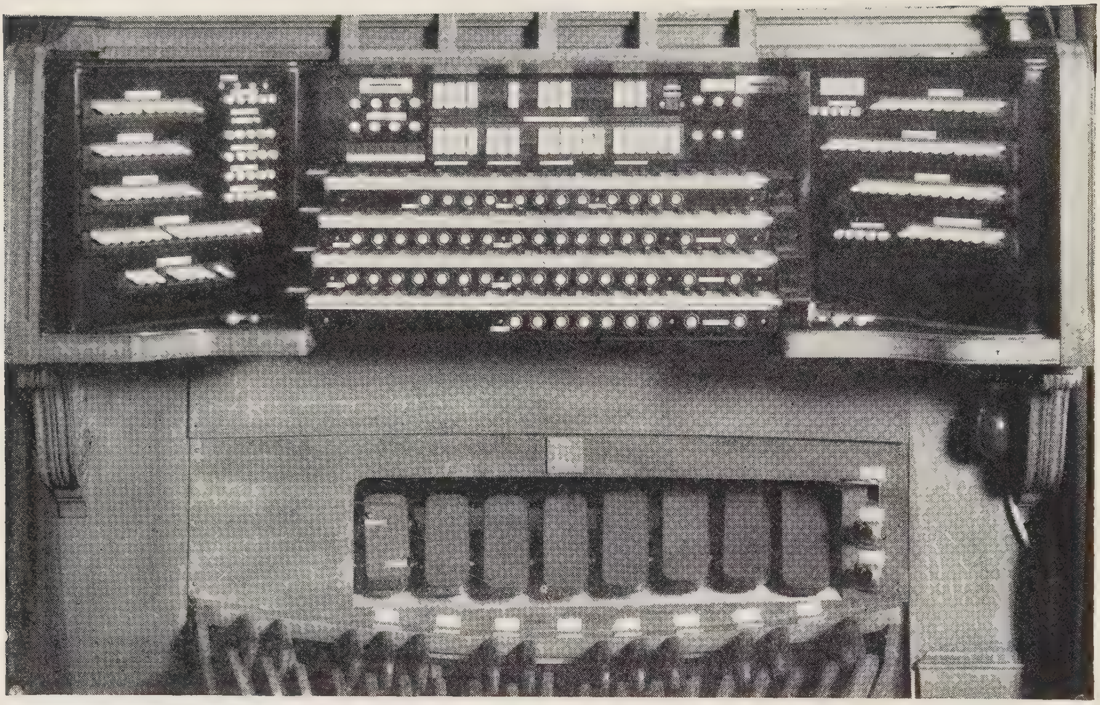


Plate XI.

The Moller console in the Washington, D. C., Auditorium. The Moller Company are equipped to build various types of consoles to suit the taste of any organist. This organization frequently manufactures at the same time as many as six distinct types of consoles.

CHAPTER 11.

GENERAL REMARKS *on* TONAL DESIGN

WHEN I contemplated writing this book, one of the subjects that I thought it wise to avoid was the Tonal Design of the Organ. But, I find that I cannot conscientiously avoid it for it is one of the most, if not the most important subject in organ building. I realize fully that we are embarking on a discussion that is necessarily a matter of opinion. And there is nothing so difficult as to write impartially when opinions and personal ideas are involved.

My experience as associate editor of the "American Organist" for the past few years, as well as regular perusal of the specifications printed in "The Diapason," since that estimable publication was started twenty years ago, will very likely permit me to speak in a somewhat qualified way of the present day tendencies in tonal design of the American organ. That there is a tendency in the direction of the more classic type of organ tone seems unmistakable.

At present the matter of tonal design in America is somewhat in a state of transition, and there are a good many opposing forces at work.

It is customary in works dealing with tonal design to give numerous specifications of organs which are considered important examples. There was much more occasion for this formerly than now. Since "The Diapason" has made it a practise to print the specification of nearly every important organ in America that has been built during the past twenty years, it seems advisable to reproduce only a few model specifications with explanatory remarks. Unfortunately, the usual specifications presented mean very little, except as far as they describe the material contents of an organ. They afford merely the vaguest guess as to the actual tonal result, unless the reader happens to be familiar with other examples of the work of the particular builder whose specification is being examined. Mr. T. Scott Buhrman, editor of the "American Organist," has for many years past, tried to insist on presenting specifications which appear in his journal with more detail. Facts such as relative dynamic strengths between the different voices are indicated, materials of which the pipes are made, scales of the pipes, wind pressures employed, and any special shapes or treatment of the pipes are also noted. This is a step in the right direction. Even this does not cover the ground fully, but is better and far more informative than a mere list of stops, which is all that is generally given by the organ builders to prospective purchasers.

If the best possible specification were given to a score of builders, the result would be a like number of organs dissimilar in tone and ranging in quality from excellent to quite the reverse. In the same manner, if a score of artists were asked to reproduce some photograph or line drawing in colors, very different results would be secured.

To design an organ should involve a great deal more than writing a list of stops. In such a case, the balance of the details must be settled by the organ builder. To conceive in one's mind a finished instrument and to prepare clear notes of this conception for the organ builder's guidance and then to assume the responsibility of seeing that the original ideas are properly carried out, requires many years of varied experience on the part of one who undertakes the tonal design of any organ. He must have analysed the cause of the various effects he has noted, and have carefully sought the reasons why apparently identical pipes sound very differently in different surroundings. A competent designer should have both practical and experimental knowledge of organ building. He must also be able to refer particular instances to general principles. Certain rules of tonal design must be followed, regardless of tastes, fads, or fancies.

From our account of the construction of organ pipes, and the various attendant operations, such as voicing, tuning, and finishing, it must be obvious that the organ is only a collection of voices—a kind of mechanical chorus. The Germans very appropriately use the term *Stimme,* or voice, to express a "stop". This chorus of mechanical voices bears a close analogy to a chorus of human voices. Consequently, if a really dignified and restful pianissimo is to be obtained, it must be the self-controlled suppressed power of a number of soft stops, not a solitary soft stop (such as Dulciana). On the other hand, nothing but blatancy can be secured from the fortissimo of a very small organ, voiced to fill a church obviously too large for it.

Richness and mellowness of tone are results which are directly proportional to the number of subdued tones that are combined, all of which will blend into a rich ensemble. A marvelous example of this is the magnificent organ in the Wanamaker store in Philadelphia. This organ is still the largest and in some ways the finest organ in the world today.

One of its most satisfying features is the richness and mellowness of tone that is produced by hundreds of stops voiced with a moderate degree of power. The wealth of tonal texture is indescribable. The same volume could be secured from a small fraction of the number of stops this organ contains. Indeed, this is demonstrated admirably by a few sets of high pressure Reeds in the Ethereal Division of this same organ, which dominate the tone of ten times the number of softer registers, but produce a totally different effect. At the same time, if Solo stops are to have a distinct character, they will generally be undesirable or even harmful in combination. Their excellence may be measured by the extent to which they are found to be *not* useful in combination. This is one argument for not restricting the number of stops in an organ.

The arguments against a large number of stops are unfortunately given too much weight. Usually the reasons offered are lack of space, lack of money, or both. We shall have more to say about what to do when these latter facts obtrude themselves on the designer who wants to lay out an ideal organ. After all, the best that can be done is to secure the maximum of artistic tonal effects from a given amount of expenditure. Compromise with ideals must sometimes be made. Our chapter on Unification explains several ways of effecting such adjustment of facts to ideals.

An attempt will now be made to analyse the underlying causes which have led to the design of American organs along very different lines from the traditional, orthodox design known and generally practiced in England and on the Continent for hundred of years. Then, I shall try to show the sound reasoning which is resulting in a return to this "classic" type.

The period embraces roughly, the last thirty or forty years. We must consider two or three very important factors affecting tonal design in America. In the first place, our organs, prior to 1890-1900, seldom had more than the unison couplers; that is, the Swell to Great 8 foot, and Choir to Great 8 foot couplers, with possibly one octave coupler. With the tracker action this was all that was possible without making the weight of the action so heavy as to render the organ impossible to be played. If octave couplers had been introduced, no practical use could have been made of them without at least a pneumatic stack, which was simply a means of assisting the organist in opening the pipe valves. This was usually attached to the Great Organ keyboard. This action with a Great Organ separation is described in our chapter on Organ Actions.

Prior to this time, it was necessary for organs to be fairly complete in upper work, particularly with regard to 4 foot stops and 12ths and 15ths and frequently many ranks of Mixtures, in order to have any brightness of tone at all. About this same period, Mr. Robert Hope-Jones came into prominence with New Tonal ideas that the more enlightened of our builders and organists are beginning to consider (or have considered for some time past) to have been in reality anything but helpful to the tone of the American organ.

Mr. Hope-Jones advocated the complete suppression of Mixtures, and even the elimination of any kind of upper work to support the Great Organ Diapasons. The Diapason tone which he introduced and which was copied by a number of our builders was the Phonon or 'flutey" and harmonically dull type, which did not lend itself to upper work. It was very erroneously thought that the keen string tones which Mr. Hope-Jones introduced so liberally into his organs, would supply all the harmonic development necessary. This was perhaps the greatest fallacy of any of the many that are now evident. In the first place, these very keen string tones do not blend in any way with a good organ ensemble; in fact, they only serve to ruin it. Though this type of tone has undoubtedly a legitimate place in the concert organ, or a very large church organ, much used for concert purposes, it must be omitted from the full tone, or mar the effect. When tracker actions were replaced by newer forms, octave couplers were freely introduced. These were thought to be substitutes for four-foot stops. Accordingly, four-foot stops were very lightly regarded. It became the fashion to omit a four foot Diapason or octave from the Great Organ and almost invariably from the Swell Organ.*

A little later a new type of organ was being developed for use in the theater where ensemble was not considered at all, as it was seldom necessary to play full organ. If it were attempted, a dreadful collection of unblendable tonal ingredients would be perpetrated on the ears of any discerning musician. The first and last thing desired in a theater organ is a variety of solo effects of as many kinds as the size of the organ will permit. During the time of its high vogue the voices of the theater organ were consistently of the most pungent and extravagantly developed character. The String tone was of the keenest type; the Flute tones introduced were of the largest and most "hootey"

---

*Reference has been made from time to time in this work to Mr. Robert Hope-Jones and the remarks we have made above may seem to be disparaging to him. I was impressed, in reading over the "Dictionary of Organ Stops" by Mr. Wedgwood, with the remarkable number of stops that are there attributed to Mr. Hope-Jones. Nearly all organists and builders are familiar with the voices that have been freely copied and introduced in organs that are generally attributed to Hope-Jones, namely the Phonon type of Diapason, the smooth Tuba Sonora, the Diaphone, the Oboe Horn, the Tibia Plena, Tibia Clausa, etc. He appears, however, to have invented a large number of other less known stops. I by no means share the intense dislike of Hope-Jones that many builders entertain for his ideas, both tonally and mechanically.

It is a curious circumstance that the three companies with which Mr. Hope-Jones was associated in America for a greater or less length of time, notably, the Austin Organ Company, the Ernest M. Skinner Company and the Wurlitzer Company, all have been remarkably successful in their respective fields of organ building. Whether it is because Mr. Hope-Jones was associated with them at one time, or because they let him go, in each instance, that they have been successful, is a matter that can only be surmised. There is no doubt but that his influence is waning and that many of his ideas and theories on tonal design have been exploded, and abandoned, as being incorrect. On the other hand, we cannot, in all fairness, by any means overlook the widespread influence of his mechanicharacter; the Chorus Reeds were generally of the Tuba or more "honkey" kind, while the Diapasons were of the Phonon or Big Flute variety. All of these elements, no doubt, had a desirable place in a theater organ. They certainly, by no stretch of the imagination, could blend into a good ensemble. The past tense can now be used in describing the theater organ, as all indications of recent years point to its being a thing of the past. Its influence was harmful on the development of a true ensemble.

It must be admitted that the theater organ influenced the design of church organs greatly, and the many "trick" effects that are so beloved by theater organists—the Vox Humana, Harp, Chimes and big Flutes with sobbing Tremolo—came to be considered necessary for even a small church organ. Harp and chimes have a legitimate place in church and concert organs, but not at the expense of more essential tones.

It appears to me that the Hope-Jones' influence in tonal matters, combined with the bad influence that the typical theater organ had on the appreciation and discernment of really good organ tone, were perhaps the two biggest factors in causing the design of church organ in this country in the past thirty years. We may say that fortunately, a change is coming about, although slowly, with many of the organists and some builders fighting this change. As for example, I read in one of the journals of an organist who bought a certain builder's organ because "he did not want his church organ to sound like a brass band." Apparently this was another way of stating that he did not approve of brilliant Chorus Reeds in a church organ. There are doubtless many like him. I have no particular quarrel with this person. He would not wish for any upper work, or a true Diapason Chorus either, but would be perfectly content and satisfied with the conventional organ we have been building, whose tone many of us have come to think of as

---

cal inventions on the development of the modern electric organ. Silver wire contacts, more efficient magnets, individual swell shutter motors, a systematic adoption of the method of unifying an organ, and many other mechanical improvements are due to Hope-Jones. Some of these things are not considered an unmixed blessing, particularly the matter of unification, which will be treated in a later chapter. Nevertheless, though he may not justify the words that have been used concerning him, that he was the "greatest mind engaged in the art of organ building in this or any other age," the truth concerning him doubtless lies somewhere between this statement and the judgment of those who utterly condemn him. This is where I am inclined to place my estimate, viewing the matter in as impartial a light as possible. That he was a mechanical genius, who came into organ building with the fresh viewpoint of the outsider, not being satisfied to do things as they had always been done, cannot be denied. Along many lines he was an idealist. He made many mistakes which, had he lived longer, he might have been the first to correct. In doing as much pioneer work as Mr. Hope-Jones did, there were bound to be mistakes and misapprehensions. That he exerted a profound influence on organ building for the past thirty years, some of it for the better, and some of it for the worse, is at least recognized by anyone acquainted with the facts.

He had the faculty of stimulating thought in his associates, who in many instances carried out and developed his ideas.

"churchly". I thought so myself for many years, until I went into tonal matters more deeply.

Mr. Henry Willis remarked to me a few years ago that he did not know where it was possible to find a collection of so many specifications of organs that were tonally badly designed as appear from month to month in "The Diapason." As "The Diapason" has always aimed to be chiefly an accurate mirror of what is happening in American organ building particularly, and the activities of the organists, this no doubt was intended to be a very severe criticism of the tonal design of typical American organs as they were being produced.*

Without wishing to quote Mr. Willis as spokesman for all that may be said on organ tonal design (though it must be admitted he has much right to speak along these lines), we must state emphatically that there are certain fundamentals of sound design that have been largely neglected in America in the past thirty years or more. Formerly I did not think so, and have myself added to the list of organs whose specifications have appeared in "The Diapason" which Mr. Willis so roundly condemns. To give an example of a typical small three manual specification such as may be found any month in "The Diapason" for many years past, let us consider the following: The Great will consist of one or more Diapasons, usually of the wooly, flutey, Phonon type; a large Flute, such as Gross Flute; perhaps a Gamba and Gemshorn; a four foot harmonic Flute and a "honky" Tuba. In the majority of cases, there will be no octave nor any Mixture work or, if by chance there is, there is practically never any mutation work or as much as a 15th.

The Swell will consist of a unit Flute playable at from four to six pitches, usually too large in scale and the wrong quality for such use being made of it. Then there will be three or more ranks of Strings of various degrees of strength, another wooly Diapason, an Oboe and Vox Humana, and perhaps a mild Cornopean.

The Choir Organ will contain a pair of Dulcianas, one tuned flat or sharp, a Melodia or Concert Flute, a four foot Flute, and a Clarinet. There will also almost invariably be Harp and Chimes, and perhaps an Echo organ.

The Pedal Organ will have a Diapason played at 16′ and 8′ and a

---

*Theater organs beyond doubt served to popularize the instrument for entertainment purposes. Such outstanding theater players as Messrs. Mallotte, Edward Dunstetter, Edward Benedict, Lloyd del Castillo, to mention only a few, when silent movies were at their height, added much to the entertainment by their artistic playing in the theater idiom.

The organ has received wider publicity from its use in the theater and from broadcasting in the past few years, than for many centuries previously. I constantly meet people who tell me about the marvelous organs they hear over the radio, or in some theater. If these people can be educated to know what a good organ really is by hearing organs of beautiful tone, either on the radio, in concert or theater, much will be accomplished.

Bourdon at 16′ and 8′ and a second Bourdon from the Swell 16′ Flute.

There have been literally hundreds of organs placed in churches all over America with approximately these specifications. I repeat, there are a great many organists in this country, and no doubt organ builders, who consider this specification quite ideal. Otherwise, why have so many of these organs been built and why are they continuing to be built?*

Another reason for the prevalence of the type of organ I have described is, as Mr. Noel Bonavia-Hunt states, "Many people never go beyond the second stage of tonal appreciation in which they revel in harmonicless or unmusical tones."

A real authority on tonal matters is Mr. Donald Harrison, who is now associated with the Skinner Organ Company as Assistant Manager, and who has had many years' experience with Henry Willis in London, with whom he was a partner. Mr. Skinner states, "His knowledge of tonal design is 100 per cent," which is slightly higher than Mr. Skinner rates his own (to quote Mr. Skinner's own words in this matter). Mr. Harrison, speaking of conflicting opinions on tonal matters, says, "For an opinion to be worth anything, it is necessary that the person offering it, has reached the final stage of tonal appreciation." The final stage to which he refers, is that reached when a person appreciates and demands a tone that has proper harmonic development, with a proper balance to the ensemble. Such a tone can never be obtained without the use of harmonic corroborating stops, such as Octaves and Mixtures and a liberal supply of Chorus Reeds. Mr. Skinner himself, as long ago as 1917, in his book on "The Modern Organ", states, "In planning the specifications for an effective organ, the Swell organ should be provided with a full equipment of Chorus Reeds of 16′, 8′ and 4′ pitch, a good Diapason, 4′ Octave and Mixtures. These six stops on a good pressure and well voiced will insure a fine crescendo."

Mr. Skinner is now building practically all of his organs, even of moderate size, with this foundation for the Swell organ, though for many years the taste of American organists had not been educated to the point where it was possible for him to insist on this foundation.

---

*The larger number of these organs are in small churches seating from two hundred fifty to seven hundred people. Small American churches are not likely to create conditions favorable to the development of "Cathedral tone" from an organ. The worshippers also prefer "intriguing, melodious sounds, not Diapason Choruses," to quote Mr. T. Scott Buhrman, Editor of the "American Organist," whether in New York City or Eagle Grove, Iowa." This is very largely true, but people's tastes may be educated.

Americans are likely to wish to imitate what their neighbors have. Having grown accustomed to an unchurchlike edifice, many of the congregation will want and appreciate some softening, sentimental or possibly religious feeling in our church music. Englishmen can't tolerate any kind of organs but what they are used to, which they *know* must be right. They are more inclined to take their religion as a duty, and probably listen to the organ in the same spirit. Americans cannot be blamed for enjoying their religion through the medium of sweet Solo stops. By all means, let us have them in the organ, but let us also have an organ besides. Let Americans once hear, in a real Gothic building a true ensemble and they will be uplifted by its sheer beauty.

Some months ago, I wrote an article for the "American Organist" in which I attempted to reconcile the opinions of those who hold that Reed Choruses and Diapason Choruses are absolutely correct for a church organ and the views of those who still think that the usual type of flutey, "woofy" organ is still to be preferred. Among other things I mentioned that an organ will certainly have a more "thoroughbred" quality when Chorus Reeds and Mixtures are liberally provided. These matters are, I realize, still highly controversial and are somewhat a matter of taste, but taste undoubtedly can be educated.*

When we can get the gorgeous ensemble, with brilliant Reeds and Mixtures, characteristic of the best English organs, combined with the great variety of lovely Solo Reeds and soft, subtle effects in which American organs already excel, we shall have achieved a closer approach to perfection in organ tonal design than we are ever likely to by proceeding along the lines that have been generally followed the past thirty or forty years by nearly all American organ builders. The builders themselves are recognizing this, and the recent work of some of them shows the tendency to return to the classic design of an organ and combine with it the wealth of lovely soft effects as well. If some builders are not now building this type of organ, it is because they do not believe their purchasers want it.

A very important influence that is hastening the change in ideas of what constitutes a properly designed church organ in America at the present time, is the vast change that has come over the architecture of American churches. The type of church architecture, if it could be called that, that was prevalent during the 1870's and 1890's, a period when architecture in all forms was at its worst in America, exerted an influence on the design of church buildings for many years thereafter, particularly Protestant churches. They were frequently not much more than square barns, usually with very poor acoustical advantages.

The present tendency in design for all churches is a return to the Gothic type of edifice, in some cases considerably modified. When this latter type of building is not too heavily treated or padded with one of the various forms of sound absorbing materials, its acoustical advan-

---

*I well recall a harmony teacher I had at Harvard University, who used to tell his class when a new chord or progression was introduced which sounded strange or unusual and which they did not appear to care for, that they should take it home and play the progression on the piano until they *did* like it.

Thus, can taste be educated and developed. Without wishing to be classed as a "highbrow" in the language of a friend who calls one "a person who has been educated beyond his intelligence", I have become "highbrow" enough not only to prefer the organ that has its proper complement of Chorus Reeds and Mixtures, but to be very little interested in an organ that does not contain these features. So much for my personal ideas on organ tonal design. A trip to England might change the opinions of some who do not agree. The organs I heard there certainly opened my eyes and ears to what Mr. Donald Harrison has in mind.

tages for the organ are normally very good. There is always a question which has to be compromised at this point, as to how much the building shall be padded to make the acoustics good for speaking and how little they can be padded to make the acoustics better for the organ and vocal music. An excessive resonance or echo is probably worse than no resonance at all. A moderate amount of reverberation, say three seconds, may be considered to be ideal for generating the most beautiful sound effects from a church organ.

Most acoustical engineers favor entirely too much padding, and have ruined the effect of many fine organs thereby. When employed, padding should be placed on the wall and ceiling surfaces of the building which are farthest removed from the source of sound. The manufacturers of deadening materials for this purpose naturally advise maximum use.

It has already been pointed out that without question the bright Chorus Reeds and Mixtures are much more effective and successful in a building with a certain amount of reverberation. As Mr. Harrison so well states, under such acoustical conditions these tones "possess a blaze of beautiful color having a strong intellectual and deep emotional appeal."

As we get away from the barn-like or concert hall type of church building to the noble arches of a Gothic structure, even if carried out on a miniature scale, we are creating conditions that make the classic type of organ ensemble highly effective and more urgently demanded.

I now wish to quote at considerable length, from an article which was written by Mr. Donald Harrison for the Skinner Organ Company's official house organ, "Stop, Open and Reed". Though in this there is naturally a certain amount of partiality for the Skinner organ, the ideas which Mr. Harrison expresses are unquestionably so sound and conservative and discerning, that they are worthy of the most careful study by any interested student of organ tonal design. I know of no one more qualified to speak than Mr. Harrison. His long and intimate study of the finest organs in England, as well as on the Continent, with a remarkable discernment of taste and appreciation at all times to detect what is best and what is bad in these organs, and later his similar careful study of American organs, gives him a breadth of view that can seldom if ever be matched. Mr. Harrison shares with most English organists and builders the idea that a good organ must first and foremost be one on which the compositions of Bach can be played satisfactorily. This seems to be sufficient for many Englishmen. He goes further than this, and agrees with our American organists and builders in wanting a wealth of beautiful color, as is produced by lovely Solo Reeds, Flutes, Strings, and similar stops after the foundations have been provided.

TONAL DESIGN OF THE ORGAN

Regarding the tonal side of the organ, it has been impressed upon me by my friends that this country demands great wealth of color in the organ and, indeed, it has been a great experience to become thoroughly acquainted with the wonderful orchestral imitative stops, to say nothing of the exquisite and colorful soft work as developed by Ernest M. Skinner.

On the other hand, admitting this wealth of orchestral color it seems strange to find in the traditional voices which are peculiar to the organ a paucity of color not only in the individual stops, but by the omission of upperwork. The ensemble of the classical organ scheme, when carried out correctly, possesses a blaze of beautiful color having a strong intellectual and deep emotional appeal.

The organ has a wonderful literature and every organ small or large should be designed so that both the classical and modern works from this literature can be played effectively upon it. Much of the best organ music, and orchestral music for that matter, is contrapuntal in form, which requires extreme clarity and crispness of tone if the beauties of these works are to be heard by the listener. Only recently I was reading a criticism of an organ recital in which it was lamented that the inner parts in the tenor of a certain composition were inaudible or obscure. It was intimated that this was a fundamental defect in the organ. It may be so in many modern instruments, but need not be so, and certainly was not so when Bach wrote his great works.

—

The cutting out of the natural color from the Diapason work and Chorus Reeds of the organ in this country naturally resulted in the elimination of the Octave and Mutation work, or its whittling down to a point where it was unobtrusive and of no practical value. An instrument of this type may be highly suitable for the playing of the lighter type of organ music and of colorful orchestral transcriptions, but owing to the lack of clarity, proper build-up and ensemble, it is ineffective for the great works of Bach, the highly vivacious movements from the modern symphonies of the French composers, and in the most part for transcriptions from the great orchestral overtures and symphonies.

I believe there are two main causes which helped to bring about these conditions—first, the absence in this country until recently of many great resonant cathedrals as found in Europe, and second, the much wider use of the organ here as an instrument of entertainment in the home and elsewhere instead of being confined to the church and large auditoriums.

It is well known that pure organ voices and the organ ensemble are exceedingly sensitive to their acoustic environment; their dignity and impressiveness are greatly enhanced by the resonance of a fine church. In smaller buildings and particularly where the acoustics have been deliberately and unfortunately reduced to those of a broadcasting studio, the more intimate effects find greater favor with the musical public.

In addition to the above it must be remembered that the traditional organ scheme, particularly when large and complex, not only requires the most careful design by the builder, but every rank of pipes has to be voiced in correct relationship to the others and then finally finished on the site, allowances being made for the effect of the acoustics or position on various stops. The relatively large production of organs in America and the enormous size of the country makes personal attention of this kind exceedingly difficult.

It is far easier to reproduce in large quantities individual solo and soft accompanimental voices and foundational Diapasons which are naturally less sensitive to acoustics. I do not cite the above in way of disparagement; rather do I feel that something really worth while has resulted from these conditions. The truly musical value of such voices as the French Horn, English Horn, Strings, Flute Celestes and Erzählers cannot be overrated, and, in fact, when added to the traditional scheme the instrument seems to reach the ideal and it is difficult to say in which direction further development is possible.

Often the term "ensemble" is used very loosely in connection with the organ; in fact, in the minds of many, a fine ensemble appears to mean a collection of voices which when played together produce an enormous amount of power or noise, whereas in reality the perfect organ ensemble can be produced in miniature.

Although different types of ensemble should exist on the various manuals of a modern organ, the underlying principles remain the same, as also in the case of the tout ensemble. Take, for example, the Great Organ, where we expect to find the true organ voices in the greatest abundance. The various ranks of the Diapasons from the Sub-Unison through the Unison, Octave, Twelfth, Fifteenth, Seventeenth, Nineteenth, Twenty-first and Twenty-second, etc. (and in large organs through the 16-ft. harmonic series) will be so voiced, scaled and regulated that when combined they produce one single tone of great clarity, brilliance and transparency. This tone is a complex one, to be sure, but the various units fit together something like the pieces of a jig-saw puzzle and present a perfectly blended picture to the listener. The Sub-Unison will hug the Unison and the upper work extend same; no rank will be unduly assertive, but all will be in perfect balance, each doing its share of the work.

In addition to the above the voices should be so finished that when starting with the Unison and adding the other ranks one by one an even crescendo or tonal build-up is produced; each step will mean a change of color, perfect blend being apparent at all the stages.

If Reeds are present on this department they should be voiced so as not to detract from the general Flue character of the ensemble. An ensemble of this kind, even when of great power, can be played for a long while without tiring the listeners, while a single rank of equivalent power would be aggressive and only tolerable for very short periods at a time.

As an example I have taken the Diapason structure of the Great Organ, but the same ideals can be applied to the Reed and Mixture ensemble of the Swell Organ or a String ensemble. It is important to remember that it is the whole Diapason structure that forms the backbone or foundation of the traditional organ and not merely the unison Diapason, as is often believed. The unisons are naturally the most important ranks of the main structure, and too much care cannot be given to voicing them. They should be of statuesque beauty and must be capable of blending with the other members of the family.

In view of the fact that the power of the ideal type is limited and requires a comparatively low wind pressure they should always stand on an open chest. The enclosure of the Diapason chorus necessitates the forcing of the tone if it is to form a true great organ in correct balance for the rest, thereby destroying the beauty and clarity, and, further, its efficiency for the playing of music on the most noble section of the instrument.

—

How is it that a good program, played by one of our finest organists on, say, the organ at St. Ouen, Rouen, France, or St. George's Hall, Liverpool, or St. Bartholomew's, Armley, is entirely satisfying and thrilling to the musical public? It would be difficult to find three organs differing more in tonal character. They are each stamped indelibly with the personality and nationality of the men who created them, and yet all three answer their purpose equally well, and can more than hold their own with many modern instruments, although they have a minimum of enclosure and also little orchestral color. The answer is that not only are the tonal schemes along traditional lines, but Cavaillé-Coll, Father Willis and Schulze followed (perhaps unconsciously) the fundamental laws and rules of traditional organ building which make for perfection of build-up and ensemble.

Composers of music use the same rules of harmony and counterpoint and yet produce characteristic works. Of course, they sometimes develop these arts or deliberately break the accepted rule. Laws and rules are made to be broken, but it must be remembered that the better one knows the laws, the easier it is to break them without getting into trouble. You can "sail closer to the wind." The same truths apply to organ building and are not merely matters of opinion.

The best works of the three builders mentioned above will continue to live. They will not be replaced by modern instruments, but will have their mechanism replaced as required and perhaps have some modern colors added to them. Manv of their contemporaries were considered first-class builders of their day, but their instruments for the most part have been rebuilt in such a manner as to lose their identity. In spite of correct tonal schemes, the builders failed to follow the rules of "harmony" and "counterpoint" of organ building; they did not possess a spark of the divine fire, or whatever you like to call that elusive "something" possessed by the few.

—

The student who cares to live with and thoroughly investigate the great works of these old masters of the past may discover the laws which are in common between them. Briefly they may be summed up as follows:

1. All stops employed, whether Diapasons, Octave, Mutation, String, Flute or Reed, are strictly musical in character. That is to say, the harmonic development is neither under nor overdone, but lies within well-defined limits, and the complete series of harmonics is in "phase."
2. The stops maintain such harmonic development throughout their compass.
3. The relative power of Octave and Mutation ranks to the Unison lies within definite limits and follows a certain logical order in all cases.

If these rules are adhered to and the tonal scheme is correct, it is almost impossible to go wrong. Beauty of the individual ranks, blending qualities, clarity in the ensemble are all assured, and yet an infinite variety in timbre is possible. The treatment can be exceedingly bold if desired without giving offense.

—

On the other hand, the breaking of one of these rules is fatal. Some little time ago I examined a large four-manual organ in which the tonal scheme was about perfect for its size. The builder had followed rules 1 and 3, but had largely disregarded rule 2. The treble of the whole Diapason structure faded away to weak flutes. In other words, the harmonic development had not been maintained throughout the compass. The result was lack of blend in the treble and with the octave coupler drawn the effect was really excruciating, and yet I understand the fear of this mechanical device led the builder to make this error.

I remember another instance in England where a certain organ builder had been entrusted with the rebuilding of an old T. C. Lewis organ. Mr. Lewis was a disciple of Schulze, and the Great Organ of this particular instrument had a most beautiful color. The rebuilder, however, was not content to leave well enough alone and had added a high-cut heavy-pressure leathered Phonon. "I have given to it the foundation it needed," he said with pride in his voice. In reality he had broken our rule 1. The harmonic development of this stop was below par and consequently it just stuck out like a sore thumb and ruined the ensemble and the general clarity of the effect. Happily, however, it was not necessary to use the stop, and I noted with much satisfaction that the organist had omitted it from his combination pistons.

The artist organ builder will not slavishly copy either individual stops or departments from the old masters. "Stunts" of this kind rarely come off. Rather should he endeavor to give the fundamental laws his own interpretation.

Naturally I can only touch the fringe of these subjects. The design of Mixtures alone, with the various breaks arranged to suit the particular specification in hand is one which would require several volumes.

—

The poor organ has suffered more than any other instrument from the whims of amateurs, experimenters and dabblers. Tones are allowed and even heralded as great achievements which would not be tolerated in any other musical field. "Well, it's all a matter of opinion" is heard far too often. For an opinion to be worth anything it is necessary that the person offering it has reached the final stage of tonal appreciation. As my old friend the Rev. N. Bonavia-Hunt has said, "many people never go beyond the second stage of tonal appreciation in which they revel in harmonicless or unmusical tones."

One may have personal preference for the Willis or Cavaillé-Coll or the Schulze organs referred to, since they are all artistically correct, but the man who likes better than any of these an instrument having fundamental errors cannot expect to have his criticisms or opinions taken seriously.

Finally, the ideal instrument seems to be a combination of the properly designed, produced and finished classical organ with the new, beautiful and subtle tones which have been produced in this country.

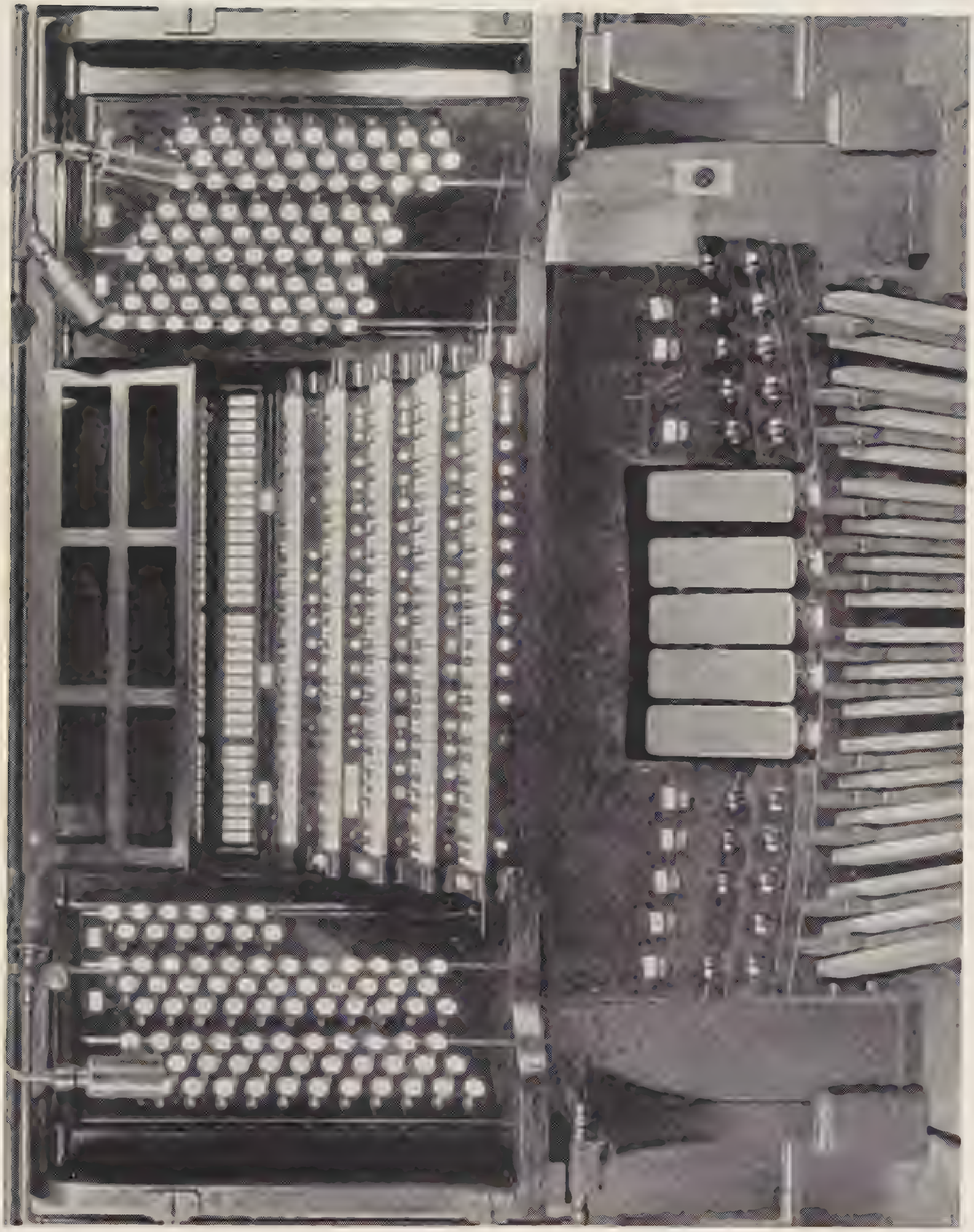


Plate XII.
The large Skinner console in the Auditorium, Cleveland.

CHAPTER 12.

SPECIFIC EXAMPLES *of* GOOD TONAL DESIGN

To bring the tonal design of an organ down to a more specific basis, I am quoting in full the paper which Senator Emerson L. Richards prepared for the General Convention of the American Guild of Organists at Memphis in 1929. One thing which Senator Richards shares with Dr. Audsley is to consider a small two manual organ to be one of perhaps forty stops. No doubt the Senator, after designing the Atlantic City auditorium organ of some thousand or more stops, would consider an organ containing only forty, a small organ. As a matter of fact, it is far larger than many churches will be able to purchase.

His ideas on the selection of stops in the order of their importance are unusually sound and logical.

An organ builder of note recently told me that after long and bitter experience he had come to the conclusion that the first three stops to be included in any organ were: Vox Humana, Chimes and Harp, and the fourth requisite was an Echo Organ. My own experience is that he does not exaggerate the conditions under which organs are being designed and built in America today.

When the average congregation desires to build, or even rebuild the church edifice it invariably retains the services of a competent architect, many times a man of high artistic attainments. But when it comes to the building of the organ it usually selects a committee consisting of a banker, a lawyer, a retail merchant, the president of the ladies' aid society and perhaps the have the requisite technical or musical organist. Such committees cannot possibly knowledge necessary intelligently to buy or superintendent the construction of the church organ. Nor in most cases do they know where to turn for competent and unprejudiced advice.

—

The word "organ architect" has not as yet gained a very high reputation. When suggested it has usually conjured up specters of commissions, double dealing and, worst of all, downright incompetence. It has been fought by the organ builders for two reasons—first, because the term has been adopted by so many persons who have not the slightest technical knowledge, experience or skill, and who, if in charge of the project, lay the builder open to annoyance, expense and criticism of the result; and, second, if the organ architect is competent, because it reduces organ building to certain common factors which leave out of consideration the special sales arguments with which the organ builder has been accustomed to obtain his contracts.

Nearly every organist, and any other person with sufficient self-assurance, claims to be competent to design and superintend the erection of an organ. In any other profession a long period of study and practical experience is required, and if the organ architect cannot show similar qualifications he may be put down as a quack and an impostor. Personally, after twenty years of study and application, the speaker has come to realize how little he really knows of the subject as compared with what ought to be known in order that the organ should assume greater significance in the art of music.

I might add that I am not alone in my ignorance. There are very few men—perhaps not more than a score—in America today who are competent to act as organ architects, and this includes organ builders as well as laymen. The last statement may surprise you. Surely the organ builder knows his business. He does know his own business—that is just the difficulty. Firmly convinced of the superiority of his own particular product, he is unwilling to inquire into the general advancement of the art or to do very much to assist in its further development. Much of the progress made in both the tonal design and the mechanical perfection of the present instrument has come from the outside. Audsley and Hope-Jones are examples.

—

There is therefore room and need for men who have sufficient general musical education to take up the art of organ design and by means of real study and research raise organ architecture to the dignity of a profession, so that there would be some competent authority to which the bewildered and ignorant church committee might apply for honest, impartial and correct advice.

—

This is all by way of prelude to the discussion of the design of two and three-manual church organs. What I have to say upon this subject can be taken as only the barest outline of the subject. There cannot be such a thing as a standard design. The organ must differ according to many factors. The first of these is the character of the service. An organ suitable to a Methodist church service would be of little utility in a Catholic church. The Methodist organ would be primarily an accompanimental organ, intended to support congregational singing. The Catholic organ is intended to support and lend emphasis to the mass and should have a radically different design. Between these two extremes there are many refinements.

The next element is, of course, the size of the church auditorium, its architectural treatment and the disposition of the organ.

The third consideration is that of extraneous uses the organ may have, such as recitals or other special musical events.

The next factor is naturally that of cost. This practical consideration cannot be disregarded entirely, but since this paper deals more with the question of design, it suffices if we consider the cost with relation merely to the completeness of the organ design.

The next consideration is that of the housing of the organ. The present craze for crowding organs into chambers behind grilles should be resisted to the utmost. A handsome organ case is one of the most imposing pieces of church furniture and deserves as much prominence in the modern church edifice as the ancient Gothic architect gave to it in the fifteenth and sixteenth centuries.

—

Within the limitations of the consideration just referred to, what, then, is good design in a church organ? It might be summed up in one word—harmony. There must be complete relation between the various voices in the organ just as there must be similar relation between the constituents of any other art. The church itself grows from its foundation upward to the ornamentation of its spire. So, too, the organ must have its tonal foundation upon which can be built the true organ ensemble.

The tonal foundation of the organ is, of course, the unison Diapason. It appears on the average organ specification simply as "Diapason, 8 ft., Metal, 61 pipes", and when it so appears it displays the complete ignorance of the contracting parties. Such matters as scale, wind pressure, composition of the metal, weight of the metal, mouth width and height, position and thickness of the languid, the matter of nicking, the tuning control, width of the pipe toe, control of the upper lip and other factors all must be comprehended under the term "Diapason" before we can have any realization of how the thing will sound in the organ.

Then the unison Diapason by itself is but part of the foundation. As perhaps all of you know, the unison Diapason must, for satisfactory musical results, be accompanied by the remainder of the family of which it is only a part. Acoustically considered, the unison Diapason is not complete in itself. It is harmonically too weak. Consequently it must be accompanied by its first harmonic, the Octave, in order that this harmonic may be artificially reenforced. It must next be supported by its sub-octave, the Double Diapason. Then it in turn should be extended to the third harmonic, or the Super-Octave. The tonal structure may then be reasonably completed by the addition of the second harmonic, or the Twelfth.

Beyond this point the harmonic structure is best carried forward by means of a Mixture made up of extensions of the unison harmonics and the fifths, such as the nineteenth, twenty-second, twenty-sixth and twenty-ninth, but which as a practical matter would be broken at, say, tenor C to a 12-19-22-26, and at perhaps the g above middle c to 5-12-19-22. This ensemble of six stops upon the great organ may be considered the absolute minimum of a true church organ. Anything less means a mutilated harmonic structure which would correspond with leaving the roof or the windows out of the edifice.

The next requisite is a second unison Diapason in order that there may be greater fullness to the harmonic structure and also greater utility when the full Diapason Chorus is not required.

—

If, then, we assume a design such as proposed, we may next pass to a consideration of the relationship between the various component parts. Assuming a fairly resonant church with the organ standing in an open position, with a seating capacity of from 500 to 800 persons, the first 8-ft. Diapason should be of fairly large scale, usually designated as a 40-scale. The second Diapason would be about four notes smaller, or a 44-scale. The Octave will have to be somewhat of a compromise, since it must have its proper relation to the first Diapason and yet be usable with the second. It would therefore be about a 53-scale, or one note smaller than the large Open. The double open would be a 32-scale, or two notes smaller than the large Open. The Super-octave can be a 66-scale, or one note smaller than the Octave and two notes smaller than the first open. The Twelfth would be a 61-scale, or one note smaller than the Octave, but voiced more quietly. The scales in the Mixture require considerable special treatment, but generally considered they should be based on the scales about midway between the first and second Diapason. In order that the treble shall be full and not inclined to a sharp, screamy quality, the scales must not diminish too rapidly; certainly they should not halve earlier than the eighteenth note.

Except under extraordinary conditions, high wind pressures should not be used upon the Diapasons. From three and one-half to three and three-quarters-inch wind will give the best results, and here will come the first fight with the organ builder. Modern electric actions made with the usual Diaphragm Chest do not work satisfactorily on light wind pressure, so that unless it is possible to supply higher action wind or the chests are specially constructed, there is likely to be trouble with the quantity of the wind supply to the pipes in attack and rapid repetition. The type of Diapason suggested here is one having an extremely wide mouth and low-cut lip, and blown with a very large supply of wind. The resultant tone is considerably brighter and undoubtedly far more musical than that of the high-pressure flute-like type of Diapason so prevalent in American organs. The reason Diapasons so treated are much brighter in quality lies, of course, in the greater development of the harmonics, and it is necessary to develop the harmonics in order to properly support the super-structure to be erected thereon.

The principal reason why Twelfths, Fifteenths and Mixtures sound harsh and screamy when drawn in the average American organ is in the inability of the various elements to attach themselves together. By that I mean that the Octave must find some octave development in the unison in order that it may harmonically join with it, and that the Twelfth and Fifteenth and the Mixture elements must likewise find their foundation in the parent ranks; otherwise the elements stand apart and there is no cohesion of tone.

The second Open can be made quieter and somewhat less brilliant in quality, but still capable of adding to and enlarging the major Diapason. The balance of the super-structure will, as indicated, be treated in harmony with the Unison Diapasons.

The double Diapason is an extremely important constituent in the ensemble, and for this reason it likewise must be well-developed harmonically. As a matter of fact, unless the Double is in balance with the Mixture, there will be no successful chorus.

—

This does not complete the Great Organ, but the next important consideration is the Reed Chorus. If there is to be only one such chorus, then it must be located in the Swell Division. All too frequently

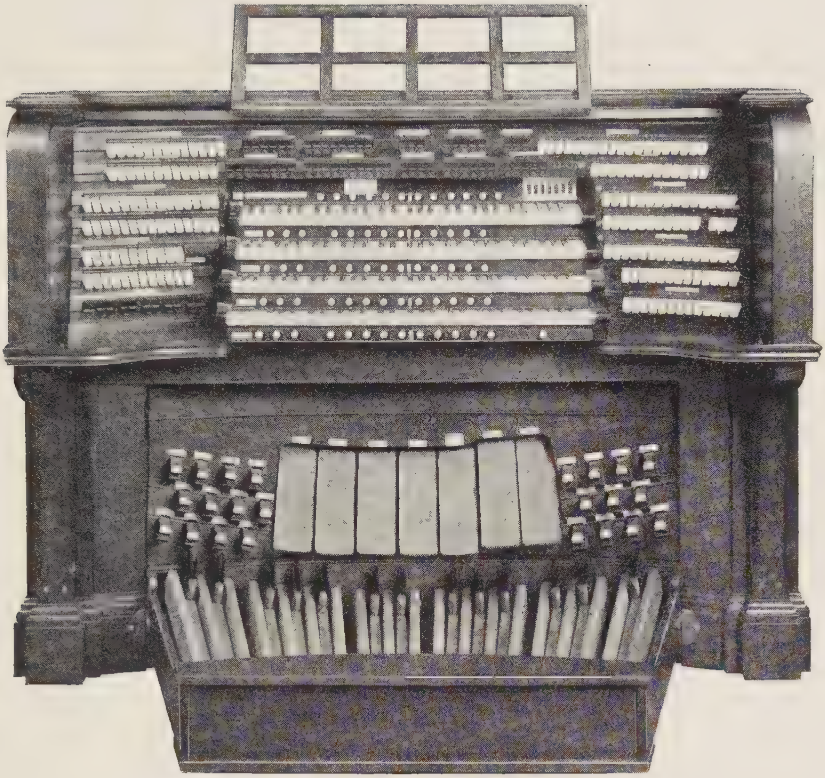


Plate XIII.

The Austin Console in St. George's Church, New York City. The organ is divided between the front and rear of the church. Hence the combination pistons are divided.

the true function of the Swell Organ is overlooked in American design. The usual prescription is a thick and muddy Bourdon, a pair of fancy Flutes, three or four nondescript Strings, an Oboe and a Vox Humana, with any other frills or fancies that the organist or the builder may favor, whereas the true foundation of the Swell Organ is the Reed Chorus.

Ideally this must consist of a Double, a Unison, and an Octave Chorus Reed of the Trumpet family. They should be well developed harmonically, so that when the Diapason Chorus has been built up to its limit, the Reeds may be added and the whole structure become a single unit of solid, yet brilliant, live, musical tone. In practice there may be somewhat of a modification in the Reed Chorus. Since the double Reed will nearly always be drawn on the pedal as an expressive Pedal Reed and thereby necessarily a unit stop, my own practice is to unify the Double Reed and obtain the Octave Reed from it by extension, thereby getting a softer Pedal Reed, a double Manual Reed and the Octave from an eighty-five pipe unit, the unison Trumpet being a straight rank.

The wind pressure on the Reeds will depend somewhat on circumstances, but should not in any case be less than ten inches and more if possible. Refinement in quality depends up to a certain point upon increased pressure, and modern Reeds will not do their best under ten inches, and fifteen is not too much. Since the Reeds are to be Trumpets the scales will be comparatively small. A somewhat larger scale may be used where they will form the only Chorus Reed family, but if there is to be a Tuba or Tromba in the design, the unison rank should not be much over five inches at CC, with the Double and the Clarion in proportion. The Eschallot treatment calls for an open Eschallot with the tongues well curved so as to produce a blaze of tone.

—

With the Diapason and the Reed families disposed of, we may then turn our attention to the Flutes and Strings. From the standpoint of organ design these are the least important, although from the standpoint of the organist one would think that they were the whole organ. There is a general practice of placing a large-scale wood Flute upon the great manual in association with the Diapasons. This is a mistake. A Flute of this character only serves to thicken the ensemble and to destroy the quality of the Diapasons with which it is associated. Tibias, Philomelas, large-scale Clarabellas or kindred voices should be avoided.

The most satisfactory type of Flute is a fairly large-scale metal Flute of non-imitative quality or a Harmonic Flute. Such a Flute is not a necessity from the standpoint of design, but becomes of very considerable utility in the execution of ordinary church music. For accompanimental purposes a Gemshorn or a Dulciana is appropriate. If the conditions demand and funds admit, there should be a second Reed Chorus upon the Great contrasting with that of the Swell. If this can be carried out appropriately, it will consist of a Double Reed, a Unison Reed and an Octave Reed of the Tromba quality voiced upon high-pressure wind.

As a practical matter, the Double may be omitted and a Tuba with an octave extension substituted, provided the Tuba is not voiced too smoothly, so that it will assist in the build-up of the Diapason Chorus. Where the Tuba is a unit (and as a practical matter it would be so constructed by almost any builder because of the different wind pressure employed), if the organ is a three-manual it may also be used on the choir and be capable of many individual effects, such as playing it against the Diapasons as well as with them.

In view of the fact that the Octave is a compromise in scale and voicing between the two unison Diapasons, if additions will admit a second Octave should be inserted early in the scheme, so that both may be in proper balance with their respective unisons.

The Great Organ would look like this:

	Ft.	Scale	Mouth	Wind	
Diapason	8	40	2/7	3¾	Metal
Octave	4	52-54	2/7	3¾	Metal
Double Diapason	16	32	1/4	3¾	Metal
Fifteenth	2	66	1/4	3¾	Metal
Twelfth	2 2/3	61	1/5	3¾	Metal
Mixture, four ranks, 19-22-26-29 12-19-22-26 5-12-19-22			2/9	3¾	Metal
Diapason II	8	44	2/9	3¾	Metal
Harmonic Flute	8	42	1/5	7½	Metal
Gemshorn	8	48	1/4	7½	Metal
Octave II	4	54-56	2/9	3¾	Metal
Tromba or Tuba	8	7½	*	10-15	Metal

*Harmonic.

We have already referred to the necessity of a family of Swell Trumpets as the primary requisite of the Swell Organ. The next stop is, of course, an additional Diapason. This can be of the smoother and fuller type, and should of course, be accomplished by its Octave. The first Flute to be inserted had, all things considered, best be a stopped Diapason as the most useful type of expressive Flute. The next stop would be a pair of Strings. If there are to be only two Strings in the Swell, they should be a fairly keen quality, but with some body. A Celeste rank should be included. A quiet Reed would, under present conditions, be almost essential, and an Oboe is suggested. In order to carry the Reed Chorus to a brilliant conclusion, it should be topped with a Mixture in which the Seventeenth may well be present.

The next addition would be an open Flute, and a Hohlflöte is suggested because of its more brilliant character and one which will unite well with the Reeds. The next, and not until then the next, voice can be a Vox Humana. It will be noted that nothing has been said about a double Flute. One almost always finds, as the very first stop in a Swell Organ, a Bourdon, a voice which is utterly out of place in the division, notwithstanding its almost universal presence. The Bourdon only destroys the clarity of the ensemble and gives a thick, muddy tone where brilliance should reign. This is true particularly when the subcouplers are used. A Reed Double is far more important and useful, so that the Flue Double may well come last, and for this purpose a Contra Melodia with a stopped bass is suggested. This may be carried out as a unit stop, playable at 16, 8 and 4 ft. and likewise upon the pedal, giving a soft pedal voice. Or if it is so desired, a Contra Gamba unit may be substituted. This would depend somewhat on whether the organ is to be a two or a three-manual.

The Swell division would then look like this:

	Ft.	Scale Ins.	Mouth	Wind Ins.	
Trumpet	8	5	..	15	Metal
Contra Trumpet	16	7	..	15	Metal
Clarion	4				
Diapason	8	42	1/5	7½	Metal
Stopped Diapason .	8	..	..	7½	Wood
Octave	4	56	1/5	7½	Metal
Viol	8	64	2/9	7½	Tin
Viol Celeste	8	64	2/9	7½	Tin
Oboe	8	3½	..	7½	Metal
Mixture, four ranks, 15-17-19-22.......				7½	Metal
Hohlflöte	8	5½x4	..	7½	Metal
Vox Humana	8	..	..	7½	Metal
Contra Melodia	16	7x7 unit	10	7½	Wood St. Bass
Melodia	8				
Flute	4				

We next come to the pedal. The pedal organ is, of course, of extreme importance. Too often it is nothing but a growl instead of a musical division. For an organ as we have suggested the minimum pedal stops would consist of a Diapason, a Trombone and a Contra Bass. All three of these stops can be extended to form the Octave and the Contra Bass extended still further to form a Super-Octave. The Tromba and the Melodia may be borrowed from the Swell, whereupon we have a reasonably satisfactory pedal organ such as this:

	Ft.	Ins.		
Diapason	16	12 to 14	7½	Wood
Trombone	16	9	15	Metal
Contra Bass	16	8 to 10	7½	Wood & Metal
Octave	8	(From Diapason)		
Tromba	8	(From Trombone)		
Cello	8	(From Contra Bass)		
Super-Octave	4	(From Contra Bass)		
Contra Trumpet	16	(From Swell)		
Contra Melodia	16	(From Swell)		
Flute	8	(From Swell Contra Melodia)		

—

If the organ is to be a three-manual, we may next consider the design of the Choir division. Naturally this division will be influenced somewhat by what we have done to the Great and the Swell. For example, if we cannot have a three-manual division, we may enclose the Harmonic Flute, the Gemshorn, possibly a Celeste rank to the Gemshorn and a Clarinet, and play this section as an enclosed ancillary to the Great. If funds permit this might be done in any event.

The usual Choir division seems to be without any very definite tonal design if one consults the average stop list in the average organ, whereas the true function of the Choir division is to represent a secondary Great organ under expression. This is true for three reasons—first, to support the choir just as the Great division supports the congregational singing; second, to afford softer accompanimental voices, and, third, to supply more tonal color. For this reason the division should be supplied with some timbre-creating voices such as the Twelfth, Fifteenth and Seventeenth. The first Reed in this division should be a Chorus Reed, and nothing is better than a

Cornopean. A Clarinet may then be added, and then a pair of fairly assertive Strings such as a Gamba and a Gamba Celeste. The double comes last and should be a metal flue of considerable harmonic development. A Contra Viol is most satisfactory, and since it again will be wanted upon the Pedal my suggestion would be an extended unit voice, giving us a 16, 8 and 4-ft., as well as the Pedal.

Such a Choir division will be found not only to have a cohesion of tone, but to be capable of very surprising effects. Upon reflection I am quite certain that you will find that a Choir organ developed along the lines suggested will supply not only satisfactory accompanimental material, but an almost endless variety of color effects. It is for this reason that the Geigen Principal and the Claribel Flute are suggested as the foundation stops. The metal Gedeckt and the Rohrflöte will also be found very effective, while the off unison stops will supply the fireworks .

Our choir division would be like this:

	Ft.	Ins.		Ins.	
Geigen Principal ..	8	48	2/9	5	Metal
Claribel Flute	8	4½ to 5	..	5	Wood
Gedeckt	8	50	..	5	St. Metal
Rhorflöte	4	60	..	5	Wood & Metal
Nazard	2 2/3	..	..	5	St. Metal
Fifteenth	2	..	..	5	St. Metal
Seventeenth	1 3/5	..	..	5	St. Metal
Cornopean	8	5½	..	7½	Metal
Clarinet	8	2½	..	7½	Metal
Gamba	3	54	..	7½	Metal
Gamba Celeste	8	54	..	7½	Metal
Contra Viol	16	44	..	7½	Metal
Viol	8				
Gambette	4				

This, then, would furnish us with the backbone of either a two or a three-manual organ that would supply general church needs, based upon sound tonal design and useful for every variety of church work. It is quite true that it does not contain any French or English Horns or other similar voices suitable to the concert organ. But the organ here designed is intended for the worship of God, in God's house, and not for entertainment.

But, you object, our church committee would not think of buying an organ without Harp and Chimes, and you may have difficulty with them. Here is a way out: Get your organ, and then single out some nice old lady in the congregation, weep a little to her, and get her to give the Harp or Chimes as a memorial. The dear departed will never know the difference, and you will have a real organ.

To apply these same sound principles of tonal design to a really small organ is an even greater problem than in the design of an organ of moderate or large size. In fact, it is probably the most difficult matter that can claim the attention of the organ designer. It has had much discussion in the pages of the "American Organist" and in "The Diapason." I quote excerpts from two contributors to "The Diapason" who seem to have excellent ideas concerning the design of a really small organ.

Mr. George H. Stanley suggests the following three schemes for a small organ. Each scheme is progressively larger in size, retaining the original scheme plus some additions. Mr. Stanley's ideas are very sound, and his arguments are convincing to the thoughful student. He states:

It has been proved time and again by the best builders of this country and Europe that in the correctly designed organ, irrespective of size, the Diapason Chorus is the foundation of the Great Organ, and the foundation of the Swell Organ is the Chorus Reeds and Mixtures. The reader can easily prove this by going to any well-designed and voiced organ and drawing the above-mentioned Choruses with suitable pedal and couplers. Now, in playing add to this combination the rest of the stops and notice how they simply "fill in" the combinations in use. Then put on all the stops except the Choruses mentioned and listen to the resulting chaos.

—

In the two-manual organ of the size under consideration the full Choruses are, of course, impossible. However, we are safe in taking for the foundation stops of Swell and Great the Cornopean 8 ft. and Diapason 8 ft. respectively. The Cornopean is to be a true Chorus Reed of the Trumpet family. This represents our minimum foundation. The Swell may then have the following voices in addition, of which the last three may be duplexed to the Great:

Diapason, 8 ft.
Salicional, 8 ft.
Chimney Flute, 8 ft.
Duliciana, 8 ft.
Harmonic Flute, 4 ft.

The Pedal Organ should never be represented by twelve pipes in an organ of this size. The Bourdon, 16 ft., is the most suitable register where only one 16-ft. is possible, and with the addition of twelve pipes a Gross Flöte may be obtained. Furthermore, all modern chests on which 4-ft. couplers act should logically have seventy-three notes.

SUGGESTED SPECIFICATION

GREAT

Open Diapason, 8 ft., 73 pipes.
Chimney Flute, 8 ft., 73 notes.
Dulciana, 8 ft., 73 notes.
Harmonic Flute, 4 ft., 73 notes.

SWELL

Diapason, 8 ft., 73 pipes.
Chimney Flute, 8 ft., 73 pipes.
Salicional, 8 ft., 73 pipes.
Dulciana, 8 ft., 73 pipes.
Harmonic Flute, 4 ft., 73 pipes.
Cornopean, 8 ft., 73 pipes.
Tremolo.

A little larger scheme follows:

GREAT

Open Diapason, 8 ft., 73 pipes.
Chimney Flute, 8 ft., 73 notes.
Dulciana, 8 ft., 73 notes.
Octave, 4 ft., 73 pipes.
Harmonic Flute, 4 ft., 73 notes.

SWELL

Diapason, 8 ft., 73 pipes.
Chimney Flute, 8 ft., 73 pipes.
Salicional, 8 ft., 73 pipes.
Voix Celeste, 8 ft., 61 pipes.
Dulciana, 8 ft., 73 pipes.
Harmonic Flute, 4 ft., 73 pipes.
Cornopean, 8 ft., 73 pipes.
Tremolo.

PEDAL

Bourdon, 16 ft., 32 pipes.
Lieblich Bourdon, 16 ft., 12 pipes.
Gross Flöte, 8 ft., 12 pipes.
Gedeckt, 8 ft., 32 notes.

Let the reader try this experiment on his own organ. Add a Swell Mixture to the Swell Gedeckt, 8 ft. Then add the same mixture to the Swell Diapason. If you have not already tried this experiment you will be amazed at the result. When the open Diapason was used the blend was good, but when the Flute was used the two voices stood apart. The answer is not in the relative power of the several stops, but in their harmonic development. It is as illogical to expect Flute tone harmonics to reenforce Swell Reeds as it is to expect a harmonic Flute on the Great to reenforce Great Diapasons. The proper Mixtures for the Swell are Diapason tone, and where a separate Mixture cannot be had the proper unit to derive them from is the Dulciana or Gemshorn.

A more complete scheme follows:

GREAT

Open Diapason, 8 ft., 73 pipes.
Clarabella, 8 ft., 73 pipes.
Chimney Flute, 8 ft., 73 notes.
Dulciana, 8 ft., 73 notes.
Octave, 4 ft., 73 pipes.
Harmonic Flute, 4 ft., 73 notes.

SWELL

Lieblich Gedeckt, 16 ft., 73 notes.
Diapason, 8 ft., 73 pipes.
Chimney Flute, 8 ft., 85 pipes.
Salicional, 8 ft., 73 pipes.
Voix Celeste, 8 ft., 61 pipes.

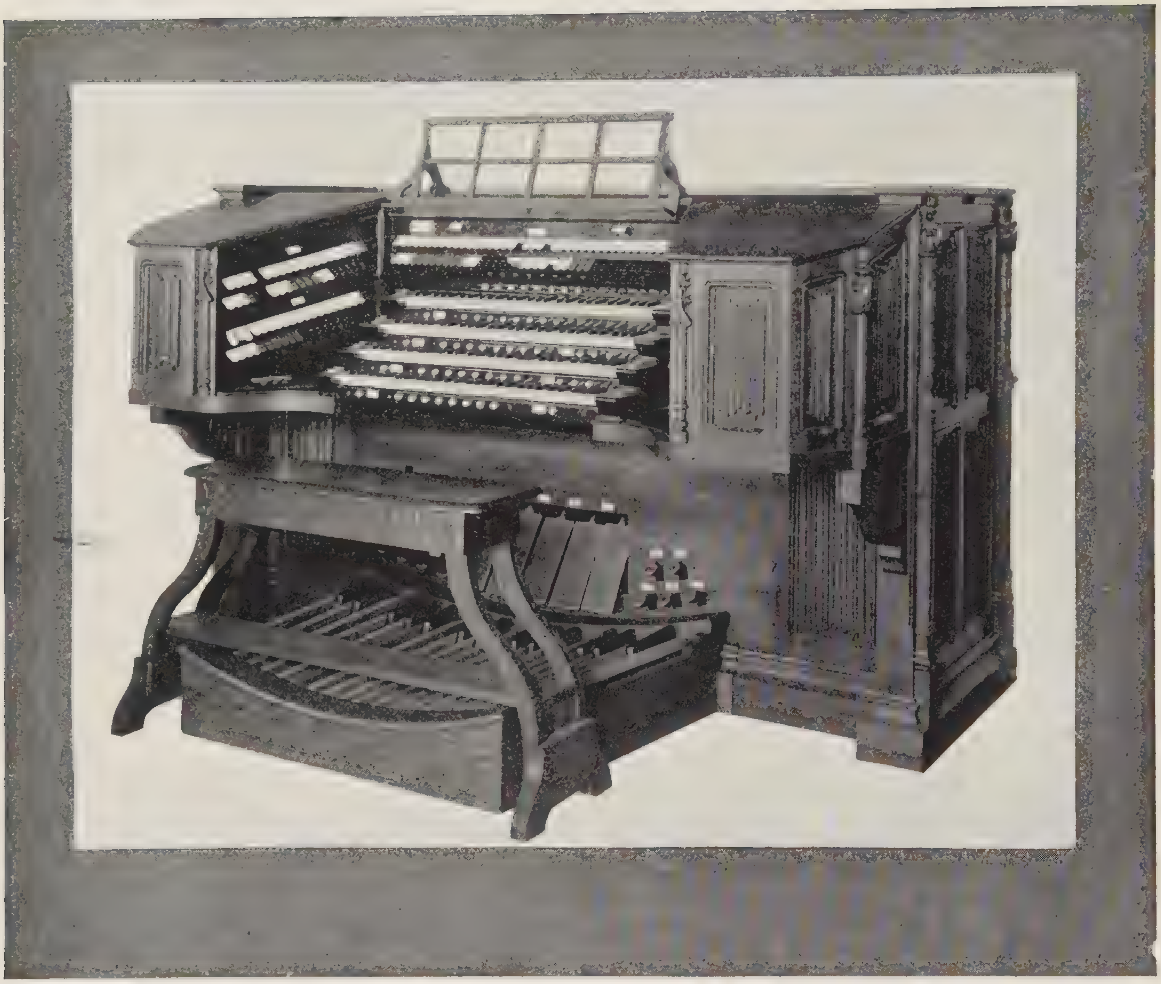


Plate XIV.

The Kilgen console that controls the Gallery organs in St. Patrick's Cathedral, New York City. The arrangement of the stop tongues in double rows across the front, permits the music rack to be placed lower, than if more rows are used over the manuals. The balance of the stop tongues are disposed on either side, at nearly right angles to the manual keys. This makes a very convenient arrangement for a large console, having all the advantages of the "Horse Shoe" type, with a much more elegant appearance for church use.

Dulciana, 8 ft., 97 pipes.
Harmonic Flute, 4 ft., 73 pipes.
Dulcet, 4 ft., 73 notes.
Dulcet Twelfth, 2⅔ ft., 73 notes.
Dulcinet, 2 ft., 73 notes.
Cornopean, 8 ft., 73 pipes.
Oboe, 8 ft., 73 pipes.
Tremolo.

PEDAL

Bourdon, 16 ft., 32 pipes.
Lieblich Bourdon, 16 ft., 32 notes.
Gross Flöte, 8 ft., 12 pipes.
Gedeckt, 8 ft., 32 notes.
Dulciana, 8 ft., 32 notes.

It should be noted that the inevitable Oboe is not added until we come to the last scheme presented. Chorus Reed tone is undoubtedly more important. The Vox Humana, Harp and Chimes are still to come.

Mr. William King Covell approaches the idea of a small organ with the statement that even a small organ should have three manuals to be satisfactory for playing organ music. He states:

There are two ways of obtaining this third manual. One is by duplexing stops from Great and Swell. The other, which is, I think, somewhat original, is by dividing the Great and having part of it played from the choir manual. The duplexing method is employed by Mr. Stanley in augmenting the resources of his Great Organs, and is well illustrated in the specifications he gives. My idea, however, can best be illustrated in a somewhat different way.

As a starting-point, suppose we take a typical Great Organ of four stops common in old organs. Translate it into modern nomenclature and make a few substitutions, and we have the following:

GREAT

Diapason, 8 ft.
Gemshorn, 8 ft.
Waldflöte, 8 ft.
Octave, 4 ft.
Harmonic Flute, 4 ft.

Suppose we divided this small Great in this fashion:

GREAT

Diapason, 8 ft.
Octave, 4 ft.

CHOIR

Gemshorn, 8 ft.
Waldflöte, 8 ft.
Harmonic Flute, 4 ft.

We now have the elements, if nothing more, of two distinct manuals. The close relation of Choir and Great makes it possible to do this to advantage. If we complete the specification we have the following:

GREAT

Diapason, 8 ft.
Octave, 4 ft.

SWELL

Salicional, 8 ft.
Dulciana, 8 ft.
Bourdon, 8 ft.
Viola, 4 ft.
Trumpet, 8 ft.

CHOIR

Gemshorn, 8 ft.
Waldflöte, 8 ft.
Harmonic Flute, 4 ft.

PEDAL

Sub-Bass, 16 ft.
Bourdon, 16 ft.
Flute, 8 ft.
Bourdon, 8 ft.

The specification just given can easily be augmented, of course. As given it represents my idea of the smallest practical organ—of eleven ranks only. The first addition I would make would be a Celeste on the Swell. Following that would be a 16-ft. Reed on the Swell, a Mixture on the Great and separate mutations on the Choir, with one more manual stop extended for use on the pedal. The specification would then read as follows:

GREAT

Diapason, 8 ft.
Octave, 4 ft.
Mixture, 4 rks.

SWELL

Salicional, 8 ft.
Voix Celeste, 8 ft.

Dulciana, 8 ft.
Bourdon, 8 ft.
Viola, 4 ft.
Bassoon, 16 ft.
Trumpet, 8 ft.

CHOIR

Gemshorn, 8 ft.
Waldflöte, 8 ft.
Stopped Flute, 4 ft.
Nazard, 2⅔ ft.
Flautino, 2 ft.
Tierce, 1-3/5 ft.

PEDAL

Sub-Bass, 16 ft.
Violone, 16 ft.
Bourdon, 16 ft.
Flute, 8 ft.
Bourdon, 8 ft.
Bourdon, 4 ft.
Bassoon, 16 ft.

In this organ two Swells will be necessary. In the Choir box the Great Mixture and possibly also the Octave would be well enclosed. The advantages of the mutations on the Choir—particularly as they are entirely straight, and can therefore be scaled and voiced each in the most effective way—must be clear. It may seem strange to use a Reed as the first manual Double. But an ample amount of Flue on 16-ft. pitch, will be introduced on the Great through the Choir to Great 16-ft. coupler. To illustrate, I give the list of tones available on the Great when all couplers are in use:

Gemshorn, 16 ft., (ten C).
Waldflöte, 16 ft. (ten C).
Diapason, 8 ft.
Gemshorn, 8 ft.
Waldflöte, 8 ft. (ten C).
Nazard, 5⅓ (ten C).
Octave, 4 ft.
Gemshorn, 4 ft.
Waldflöte, 4 ft.
Stopped Flute, 4 ft.
Flautino, 4 ft. (ten C).
Tierce, 3-1/5 ft. (ten C).
Nazard, 2⅔ ft.
Flautino, 2 ft.
Stopped Flute, 2 ft.
Tierce, 1-3/5 ft.
Nazard, 1⅓ ft.
Flautino, 1 ft.
Tierce, 4/5 ft.
Mixture, 4 rks.
Bassoon, 16 ft.
Trumpet, 8 ft.
Bassoon, 8 ft.
Trumpet, 4 ft.

This list looks like that of the Great of a large German or French organ; and, while something will be lost through the use of Choir to Great Couplers at three pitches, the effect will approximate in richness of tone that of those large European organs. It will be noted that the Swell speaks only at unison and octave on the Great, thus assuring a clear and well-balanced ensemble. I omit the Flue stops of the Swell from the list for the sake of brevity.

The composition of the Great Mixture is a significant element in this rich tonal superstructure. I would suggest that it be:

CC to g^1, 12, 19, 22, 32 notes.
g sharp^1 to g^2, 12, 15, 17, 19, 12 notes.
g sharp^2 to c^4, 5, 12, 15, 17, 17 notes.

If well scaled and voiced it should improve the ensemble distinctly.

If the specification were to be still further extended, I would have it thus:

GREAT

Diapason, 8 ft.
Harmonic Flute, 8 ft.
Octave, 4 ft.
Mixture, 4 rks.

SWELL

Geigen, 8 ft.
Salicional, 8 ft.
Voix Celeste, 8 ft.
Dulciana, 8 ft.
Bourdon, 8 ft.
Viola, 4 ft.
Bassoon, 16 ft.
Trumpet, 8 ft.

CHOIR

Gemshorn, 8 ft.
Waldflöte, 8 ft.
Stopped Flute, 4 ft.
Nazard, 2⅔ ft.
Flautino, 2 ft.
Tierce, 1-3/5 ft.

PEDAL

Bourdon, 32 ft.
Sub-Bass, 16 ft.
Violone, 16 ft.
Bourdon, 16 ft.
Flute, 8 ft.
Bourdon, 8 ft.
Bourdon, 4 ft.
Bassoon, 16 ft.

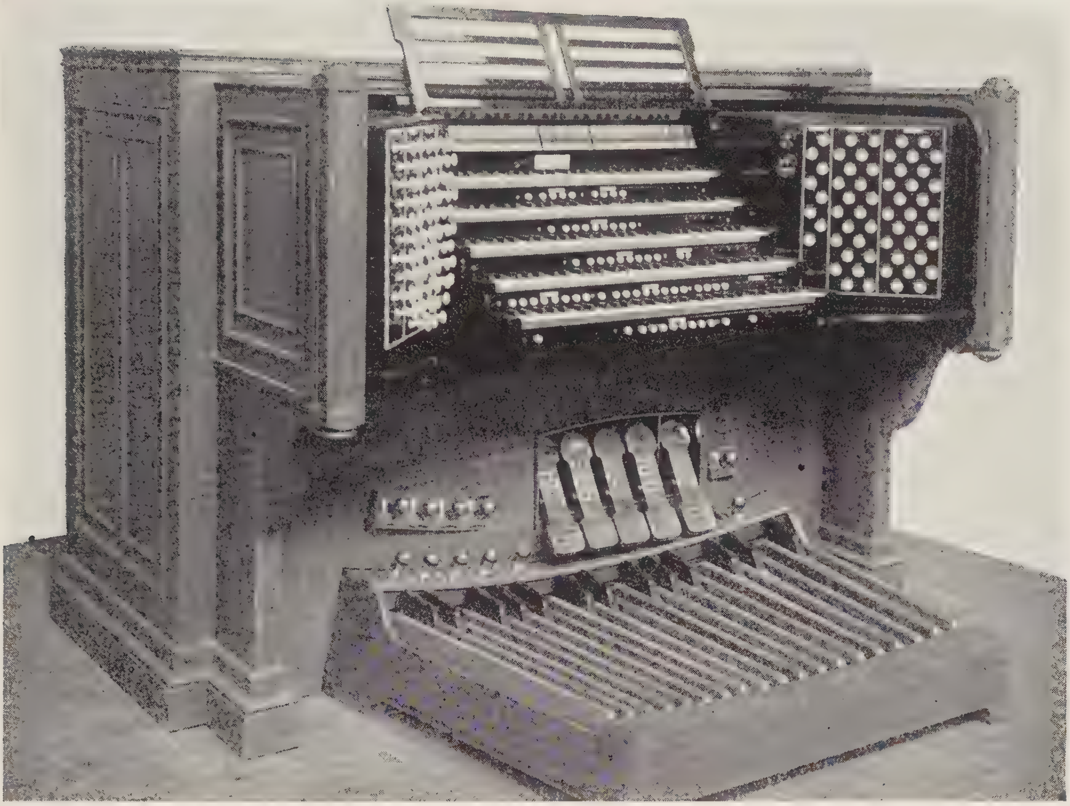


Plate XV.
The large Casavant console in the Royal York Hotel, Toronto, Canada.

The additions may be described as follows: The Great Harmonic Flute would be virtually a Dulciana in the lowest portion—twenty pipes—but harmonic from G sharp to the top. The Geigen would be brighter than the Diapason of the Great, but more solid than the String of the Swell. The Pedal 32-ft. would be a downward extension of the Swell metal Bourdon—already extended twelve pipes to form the Pedal Bourdon, 16 ft. The 32-ft. need not go below AAAA or GGGG—the remainder being resultant—but those few pipes in the 32-ft. octave would be of distinct value, particularly so if kept very soft. The Violone, 16 ft., is from the swell Salicional—a twelve-pipe extension downward. These twelve probably cannot be placed in the swell-box. There are but nineteen independent registers in the foregoing specification.

It will be noted that in all the schemes except one which Mr. Stanley and Mr. Covell suggest, there are no "unified" stops on the manuals. In some of the schemes there is "duplexing" between the manuals, and in one a "unit" Dulciana and a Bourdon at two pitches. It is more customary to "unify" several registers, in a small organ particularly, and almost inevitably the Swell Bourdon. As the typical small organ scheme that has most frequently been built of late years is well known to most organists and builders, and is one that is nearly always lacking in even a pretense to ensemble, it is scarcely important to reproduce an example of the sort in these pages. Such schemes are more than likely to be a collection of ear-tickling stops that are pleasant and reasonably useful, within narrow limitations, but with no regard for underlying principles of tonal design. All the schemes presented by Mr. Covell and Mr. Stanley do show a very wholesome regard for such principles, and are presented for that reason.

The matter of "unifying" and "duplexing" registers is discussed more fully in the chapter on "Transference of Stops." See page 186.

I will now discuss a scheme which I designed for the First Baptist Church of Evanston. In it I attempted to combine the requirements of ensemble with a wealth of softer solo voices and effects in a moderate sized three manual.

This scheme was devised after I had spent some time in England and had had the advantage of hearing numerous English organs built along the best English traditions, particularly examples built by Henry Willis & Sons. My ideas of what constitutes a real church organ have undergone something of a change since that time. I am willing to admit that concessions are to be made to the value that the English place on a satisfactory Diapason Chorus on the Great and an equally satisfactory Reed Chorus on the Swell, for even a moderate-sized organ. They are perhaps the greatest essentials of a church organ. Certainly to secure a satisfactory ensemble, these two choruses must be present in a fairly complete state.

Having become convinced of this, I am equally satisfied that the typical moderate-sized English organ is quite lacking in many of the more subtle, softer, and solo effects that are almost as desirable as these foundation tones, and that these latter effects cannot be sacrificed any more than the former.

I believe the organ under discussion combines these two very important considerations to the utmost degree possible with the funds at the disposal of the church.

The Great Organ is practically the conventional English Great Organ as found on moderate sized three-manual English organs, with the exception that the great Double Diapason is used for a Second 8′ Diapason and also on the Choir and Pedal. Three lighter stops, Melodia, Dulciana, and Flute, are duplexed between the Great and Choir Organs. Please note also the absence of string tone on the Great, such as the Gamba. This is in accord with the best English practise.

The Swell Organ has all the essentials of an English Swell, particularly the 16′, 8′ and 4′ Chorus Reeds and independent 4′ Octave, with the exception of a four or five-rank Mixture. In addition, it has the Flute Celeste and Vox Humana, which are practically never found on an English Swell of this size. The unit Flute on the Swell is justifiable from practically every consideration. This is stated after long experience with organs that contain a unit Flute of this character, also the unit Melodia and Dulciana provided on the Choir Organ.

None of these units are of sufficient strength to in any way upset the tonal balance, but provide much greater variety and color than can be had for anything like the money, where independent pipes are provided for 4′ and 2′ stops and mutations. It should not be necessary to argue this point further, but there is still some opposition to unification of any sort in a church organ no matter how wisely or sanely it is carried out.

In addition to the Melodia and Dulciana units on the Choir, there are also three Solo Reeds of quasi wood-wind character, the Clarinet, English Horn, and French Horn, which provide an excellent medium for reproducing orchestral effects and which have certainly more than justified themselves in the modern church organ. These latter stops are never provided beyond a Clarinet in anything but the largest English organs. The same applies to Harp and Chimes. The Liverpool Cathedral organ contains neither Harp nor Chimes.

If this stop-list has any weakness, it might possibly be lacking in String tone. However, the Dulciana and Unda Maris on the Choir give soft String tone, and the Salicional and Voix Celeste on the Swell are sufficiently strong and broad in tone to give all the String tone absolutely necessary. A Gamba on the Choir Organ would be an addition of value.

This scheme is submitted as being worthy of the most careful scrutiny for a moderate-sized three-manual organ costing between $15,000 and $25,000, depending on the builder.

Senator Richards' paper, already quoted, suggests a somewhat similar scheme, but I believe the following specification provides everything that can be reasonably required by any organist. In this connection it should be remarked that several of the foremost organists in the country have told me unequivocally that in their estimation this is one of the most effective and satisfactory three-manual organs they have ever played in this country or abroad. These are strong words to use about any organ, but I believe they are deserved.

It is, of course, unfortunate that no printed scheme can convey anything of the quality of the finished product, as pointed out at the beginning of this chapter. A printed scheme can only show whether the design is such that a good ensemble is possible, and the variety of subsidiary voices. No more. It would be as unwise to claim that a magnificent recital program insures a performance of like quality.

I do not feel that the omission of an independent Mixture on the Swell is a grave fault in this particular instance. The independent Chorus Reeds in this department are of such brilliance in themselves that, combined with the Diapason and Octave of their own division, there is quite sufficient brilliance and clarity to the tone to suit any taste. The derived mutation ranks from the Chimney Flute on the Swell are *not* intended to take the place of an independent Mixture on this division. They are present for "color" purposes only. In general it would be safer to add the Mixture, and it would be certainly more correct traditionally and theoretically. After all, "The proof of the pudding is in the eating thereof."

The Harp and Chimes were acquired as a memorial in the manner Senator Richards suggests they may be. They fill every requirement of pleasing the congregation by supplying tone qualities which they can easily recognize, and which seem to have such a fascination and charm for the lay listener.

The specification is as follows:

GREAT ORGAN

Enclosed in Choir Expression Chamber

1. Double Open Diapason, 16 ft., 85 pipes.
2. Open Diapason, 8 ft., 73 pipes.
3. Second Diapason (No. 1), 8 ft.
4. Clarabella, 8 ft., 73 pipes.
5. Melodia, 8 ft., 85 pipes.
6. Dulciana, 8 ft., 85 pipes.
7. Octave, 4 ft., 73 pipes.
8. Flute (No. 5), 4 ft.
9. Mixture (Twelfth and Fifteenth), 122 pipes.
10. Trumpet, 8 ft., 73 pipes.
11. Chimes, 20 tubes.

SWELL ORGAN

12. Bourdon, 16 ft., 97 pipes.
13. Open Diapason, 8 ft., 73 pipes.
14. Chimney Flute (No. 12), 8 ft.
15. Salicional, 8 ft., 73 pipes.

16. Voix Celeste, 8 ft., 61 pipes.
17. Spitz Flöte Celeste, 2 rks., 134 pipes.
18. Octave, 4 ft., 73 pipes.
19. Flute (No. 12), 4 ft.
20. Nazard (No. 12), 2⅔ ft.
21. Piccolo (No. 12), 2 ft.
22. Double Trumpet, 16 ft., 73 pipes.
23. Horn, 8 ft., 73 pipes.
24 Corno d'Amore, 8 ft., 73 pipes.
25. Vox Humana, 8 ft., 61 pipes.
26. Clarion, 4 ft., 73 pipes.
27. Harp, 8 ft., 49 bars.
28. Celesta, 4ft. 49 notes.

CHOIR ORGAN

29. Open Diapason (No. 1), 8 ft.,
30. Melodia (No. 5), 8 ft.
31. Dulciana (No. 6), 8 ft.
32. Unda Maris, 8 ft., 61 pipes.
33. Flute (No. 5), 4 ft.
34. Dulcette (No. 6), 4 ft.
35. Flautino (No. 5), 2 ft.
36. Dolce Fifteenth (No. 6), 2 ft.
37. French Horn, 8 ft., 73 pipes.
38. Clarinet, 8 ft., 73 pipes.
39. Cor Anglais, 8 ft., 73 pipes.
40. Harp, 49 notes (No. 27)
41. Celesta (No. 28)

PEDAL ORGAN

42. Acoustic Bass (Nos. 43 and 45), 32 ft.
43. Open Diapason, 16 ft., 44 pipes.
44. Second Open Diapason (No. 1), 16 ft.
45. Bourdon, 16 ft., 44 pipes.
46. Gedeckt (No. 12), 16 ft.
47. Octave (No. 43), 8 ft.
48. Flute (No. 45), 8 ft.
49. Dolce Flute (No. 12), 8 ft.
50. Flute (No. 4), 4 ft.
51. Trombone (No. 10 extended), 16 ft.

As an example of the opposite extreme in organ tonal design from those we have already quoted, we shall consider that of an almost wholly "unified" church organ, which in my estimation is a very remarkable example of this type. Mr. John Compton of London is the builder and the organ is installed in the Liberal Jewish Synagogue of the same city.

We may now be getting far afield from either traditional organ design or many practices that are ideal, but if a church organ is to be largely unified, Mr. Compton has here pointed the way for doing it with most artistic results. It is worth while to include the scheme and to comment on it rather fully for this reason alone. The organ also contains some other remarkable features which are described in the comments on the scheme itself.

It is a curious fact that a country which is normally so conservative as England in all organ matters should produce such men as Mr. Hope-Jones, Mr. John T. Austin, and Mr. John Compton. All of them pioneers in organ matters, the three of them have done more perhaps than any other three men in making the modern organ as we know it today.

The first two men came to America to get recognition and success. It is not unlikely that Mr. John Compton must do the same to reach a similar position. He is certainly not generally appreciated in England where prejudice is so strong against anything not perfectly orthodox and traditional, in organ design, as in other matters.

While the conservative element there all agree that the organ in the Liberal Jewish Synagogue is the best example of a unified organ they know, they will none of them admit that it is an outstanding organ, entirely apart from whether it is unified or not. It has only about

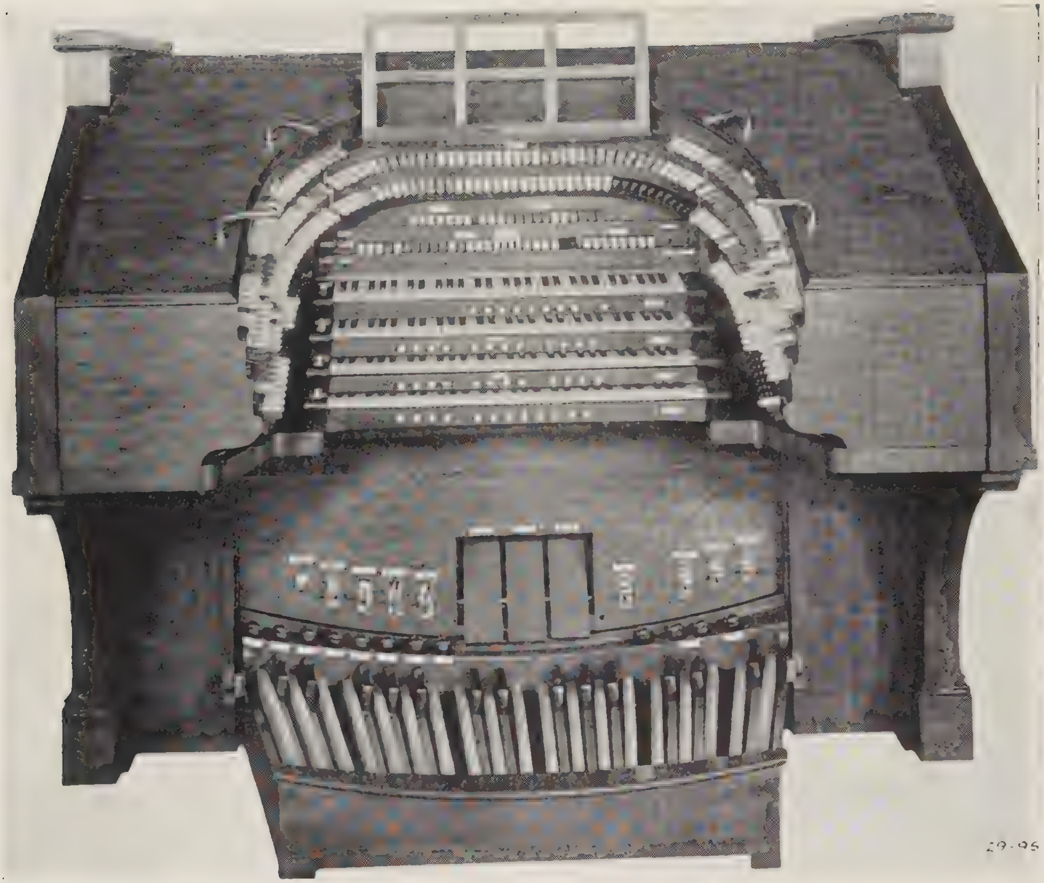


Plate XVI.

A "Horse Shoe" or theater type of console, originally designed by Mr. Hope-Jones. The one shown above was built by the Kimball Company for the Ball Room of the Atlantic City Auditorium. The Kimball Company build also excellent examples of the stop tongue console where the stop tongues are disposed in two straight rows above the top manual, and also the standard drawknob type of console. The Minneapolis and Memphis Auditoriums each have the latter type, which are both fine examples of the drawknob console.

twenty sets of pipes, yet I was benighted enough to enjoy it as much as any organ of three times this number I heard in England, and would certainly have rather given a recital upon it. The fact that it was entirely enclosed at once distinguished it from all other English church organs which I heard and gave it a warm place in my heart.

The great difference between it and other partially unified organs lies in the fact that there are no octave couplers of any kind on or between any manual. This makes it impossible for even an inexperienced player to get the terrible effects of all top and bottom and no middle, a common failing of most unified organs in ensemble.

The principal Diapason is absolutely Straight as it should be, with all the upper work and 16′ supplied by the two other Diapasons. It is quite important that there be two others in order to get just the right gradation of tone for the various mutations. Each one of the Diapasons is quite different in quality as well as in strength, and a very fine Diapason Chorus is produced that I am satisfied could not be distinguished from one of some half dozen more sets. I urge a careful study of the whole scheme.

Here again much of the success depends on the voicing; everything was done by an artist. Nowhere is really artistic voicing so necessary as in a unified organ, where every voice must count for so much and be really distinguished.

Two absolutely unique effects in the organ—the marvellous 32′ tone producing from a cube, and a 32′ synthetic reed produced by five ranks of stopped wooden pipes, all harmonics of the resultant tone aimed to be produced—should be especially noted. I consider without doubt the 32′ tone Mr. Compton has secured here so successfully, and by such simple means, to be one of the most remarkable and important inventions in organ building. Every organist should know the tremendously fine effect of a real (not resultant) 32′ in any organ, and Mr. Compton has produced one so compactly and so reasonably, that it can be placed in an organ with no more expense, and taking not as much room as a 16′ Diapason. It comes closer to getting something for nothing than anything I have seen in organ building.

Mr. T. Bernard Goodman, in writing of this organ, has the following to say:

> There are several uncommon features, but the most wonderful thing to my mind is the Pedal Basses produced from cubes. The Contra Baryphone 32 is a compound stop composed of stopped pipes; unless I had seen them I would not have credited that the tone came from such a source. It is wonderfully even in tone throughout the whole compass and it keeps in tune with the remainder of the organ.
>
> Now a few words on the Sub Bass 32′. The lowest five notes are Acoustic. Then from FFFF a cube with 4′ sides is used to produce 7 notes; then comes a smaller cube producing 7 more, which is followed with a third cube producing 7 more. They

are placed on the top of each other and only occupy one-eighth the space of pipes doing the same duty. The only point against them is the possibility of requiring two notes at once from the same cube, but close double pedalling on a 32′ is the exception. The mouth is on one side of the cube and (on the 4′ cube) about 12″ high and 6″ wide. The cap is on the outside of the cube and the mouth is an inverted one. The wind pressure is 10″ or 12″ but Mr. Compton told me that he got good results with low pressures. I noticed there were no nicks in the mouth; there is no languid. On another side of the cube are 6 holes, each closed by a controlling motor. Tuning is provided by means of sliding shutters on the inside, but in the later patterns Mr. Compton is placing the tuning slides on the outside. The cube when closed gives the lowest note; the more openings there are, the higher the note. When we consider that one can be built in any organ for considerably less than any 16′ register and does not occupy nearly so much room, we can truthfully say that Mr. Compton has solved a problem that has puzzled builders for many years.

It is a pity that Dr. Audsley did not live to see this organ for he would have revelled in some of the voicing; the Solo can claim to have the Compound Flexibility he advocated. The means of getting it would not have appealed to the eminent Dr. but the result is there; after all, if a thoroughly artistic result is obtained, one may be pardoned for not asking too many queries as to how.

Another notable feature is the Great 8-rank Mixture, the breaks of which are so skillfully contrived that one cannot say where they are. There are two Principals of varying power and two Fifteenths. These make it particularly easy to get an effective build-up whether one is playing piano or *fortissimo*. The Great Open No. 1 is full and powerful; it has leathered lips and there are two pipes to each note in the treble. No. 2 is an exact copy of the Schulze Diapason in scaling and in tone too. No. 3 is of the early English type, more like those of Green or England. They all blend well and no matter in what order they are used, each addition tells.

The Reeds are fine indeed. The Great Reeds are not quite so brilliant as the Swell. The Solo Tuba is one of the finest I ever heard. It may be used on the Great but is most telling when used against the Full Great and Swell. Another luxury is sostenuto to Choir and Solo. I believe they were first fitted about 1887 on the Mitchell & Thynn organ now in Tewkesbury Abbey. The manual pistons are Double Touch, the deeper touch controlling the Pedal.

LONDON, ENGLAND

Liberal Synagogue

John Compton

PEDAL

1	32	Sub-bass
2	16	MAJOR BASS
3		Diapason No. 19-G
4		Dulciana No. 54-C
5		Bourdon No. 23-G
6		Viole No. 38-S
7	10½	Bourdon No. 23-G
8	8	Major Bass No. 2
9		Bourdon No. 23-G
10	5⅓	Major Bass No. 2
11	4	Major Bass No. 2
12		Bourdon No. 23-G
	32	Baryphone Synthetic
	16	Baryphone Snythetic
31		Tromba No. 33-G
14		Trumpet No. 47-S
15	8	Tromba No. 33-G
16	4	Tromba No. 33-G

GREAT

17	16	DIAPASON
18		Bourdon N. 23
19	8	DIAPASON ONE
20		DIAPASON TWO
21		DIAPASON THREE
22		HOHLFLÖTE
23		BOURDON
24	5⅓	Bourdon No. 23
25	4	Diapason Two No. 20
26		Diapason Three No. 21
27		Hohlflöte No. 22
28	2⅔	Diapason Three No. 21
29	2	Diapason Two No. 20
30		Diapason Three No. 21
31	VIII	Mixture No. 21 12-15-17-19-21-22-23-24
32	16	Tromba No. 33
33	8	TROMBA
34		Tuba No. 77-L
35	4	Tromba No. 33

SWELL:

36	16	Viole No. 38
37	8	DIAPASON

38		VIOLE
39		VIOLE CELESTE
40		HARMONIC FLUTE
41	4	Diapason No. 37
42		Viole No. 38
43	2	Viole No. 38
44	IV	Cymbale No. 38
		12-15-19-22
45	16	Trumpet No. 47
46		Oboe No. 48
47	8	TRUMPET
48		OBOE
49	4	Trumpet No. 47
50		Oboe No. 48
		Tremulant
51	16	Dulciana No. 54
52		Lieblich Gedeckt No. 57
53	8	Diapason No. 21-G
54		DULCIANA
55		VOX ANGELICA
56		UNDA MARIS
57		LIEBLICH GEDECKT
58	5⅓	Lieblich No. 57
59	4	Diapason No. 21-G
60		Dulciana No. 54
61		Vox Angelica No. 55
62		Lieblich No. 57
63	2⅔	Lieblich No. 57
64	2	Diapason No. 21-G
65		Lieblich No. 57
66	III	Acuta No. 57
		15-19-22
	16	Krummhorn Synthetic
67	8	Tromba No. 33-G
		Clarinet Snythetic
68		KINURA
		Tremulant

SOLO:

69	8	Viole Celeste 2r Nos. 38, 38-S
		Violoncello Synthetic
70		Harmonic Flute No. 40-S
		Quintaton Snythetic
		Snytheton Synthetic
71	4	Harmonic Flute No. 40-S
72		Viole Celeste 2r Nos. 38, 39-S
73	2	Harmonic Flute No. 40-S
74	II	Quartane No. 40-S
		12-15
75	16	Tromba No. 33-G
76		Oboe No. 48-S
77	8	TUBA
78		Tromba No. 33-G
79		Trumpet No. 47-S
80		VOX HUMANA
		Oboe Synthetic
81	5⅓	Tromba No. 33-G
82	4	Tuba No. 77
83		Vox Humana No. 80
		Tremulant

ACCESSORIES:

Two Crescendos
Couplers as usual
Register Crescendo
7 Pistons to each manual
Movable console

In the various works of Audsley, great distinction was made between the tonal designs of church, concert, chamber and theater organs. There must, of course, be some differences. As time goes on, however, there tends to be less difference between a large church organ, for example, and a large concert organ. Nearly all large church instruments are used for concert purposes on occasion, and should have sufficient solo stops of an orchestral character to insure adequate and satisfactory interpretation of orchestral transcriptions as well as pure organ music and also to accompany the services of the church. The concert organ should manifestly be designed for the interpretation of orchestral transcriptions and organ music equally. Both church and concert organs should have a good ensemble, and be capable of producing clarity of tone so necessary to the satisfactory interpretation of contrapuntal music.

TONAL CHARACTERISTICS OF CHURCH AND CONCERT ORGANS

Mr. Meyrick-Roberts, in his interesting description of the Liverpool Cathedral organ, makes some general remarks concerning what

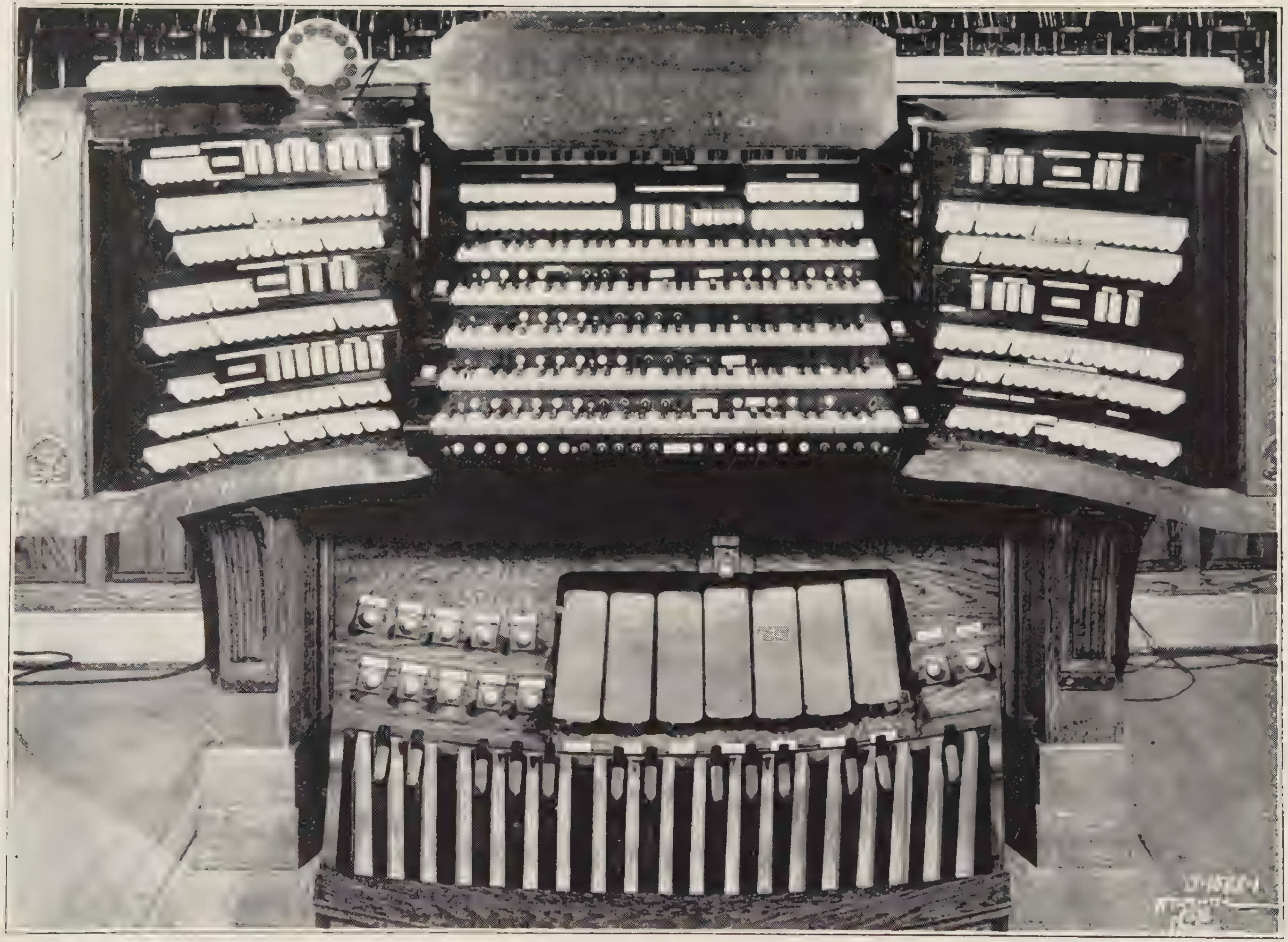


Plate XVII.

The Console of the Atlantic City High School Organ. Midmer-Losh, Builders. Unfortunately, the great console for the Atlantic City Auditorium may not be shown. It is being built by the same builder, but is not available for a photograph at the time of the publication of this book. It will be more than twice as large as the above.

should be the tonal contents of any large organ that are certainly apposite at this time in considering general characteristic of tonal design of large church and concert instruments. He states that:

> In any large organ the under-mentioned tone qualities are looked for, and are generally to be found:
>
> First of All
>
> Foundational Diapason tone on the Great
> Foundational Geigen tone on the Swell
> Dulciana (sometimes Salicional) tone on the Choir
> Stopped-flute tone (Lieblich) in various departments
> Open (and general flute tones) and Harmonic Flutes
> Gamba (old fashioned stringy tone) and modern Violes
> Tibia tones, which must be classed as powerful Wood Diapasons of a beautiful tonal quality
> Stopped "Diapasons" (as apart from Stopped Flutes)
>
> Reed Stops
>
> Chorus Reeds of the Great
> Chorus Reeds of the Swell
> Orchestral (imitative) Reed stops
> Pedal Reed stops
> Heavy pressure Reed tones, Tromba and Tuba tones (enclosed or unenclosed)
>
> Each of these classes of tone should be found in any fairly large organ of to-day. On the Great Organ the Diapasons, which form the foundational and principal tone upon which the whole tonal structure is built up, should be very adequately represented in 16 ft., 8 ft., 4 ft., and 2 ft. pitches in sufficient number of tone; and, to avoid monotony (and worse evils) in various shades of tone and scaling. This is the primary and most important tone in any and every organ. After this tone has been sufficiently well supplied, the Flute tones—open, closed and harmonic—can very well be next considered. The claims of the old-fashioned stopped "Diapason" tone, i.e., Bourdon 16 ft., stopped "Diapason" 8 ft., and the Flute Couverte 4 ft. (as Willis now names the 4 ft. variety) have of late years been overlooked by many builders, and forsaken for more (perhaps) fanciful Flute tones; but it is difficult to find any Flute tone that blends better with the Great Organ Diapasons than the old English stopped "Diapason" variety. It, of course, does not for one moment aspire to the tone of an orchestral solo flute: its true place is with the foundation stops, in whatever manual department it may be placed—the Great for preference.
>
> After this, the mutation ranks (by which is meant the ranks of pipes that give a sound other than unison, octaves or sub-octaves—i.e., Quint, Nazard, etc) and the Mixture work demand our attention. There should be, according to the size of the organ, an adequate number of these ranks to blend with and enrich the Flue stops; and Mixture work to extend and to brighten up the Flue foundation, and thus form the Flue Chorus. That is, in other words, to give on the organ of today that charming old English effect, "Great, full to Mixtures."
>
> In the case of the Swell department in an organ of limited size, one may with good reason design this department by deciding what Reed stops are desirable, thus reversing the building up of the Great organ. The Swell is the Reed department *par excellence* and at the same time it is necessary that the Flue work should be developed as far as possible on the same systematic lines as the Flue stops of the Great Organ.
>
> The old English Choir Organ though seldom very large, was, as it should be, an Echo of the Great, the stops of which were repeated in the Choir department so far as circumstances would allow, the pipes being naturally of a smaller scale and as a rule brightly voiced.
>
> The Solo organ should be a collection of Solo voices, as its name implies, with the dominating Tubas, Orchestral Reeds, and Strings. The Pedal organ should be capable of furnishing a true and suitable bass of sufficient variety and power to balance properly the manual stops.

These are the orthodox, time honored rules for designing any large organ in England. They are sound to the core, beyond a doubt.

TONAL CHARACTERISTICS OF RESIDENCE ORGANS

Turning our attention to the consideration of the residence organ, I believe in soundness of design to a limited extent only. The following examples of residence organ schemes will show my views in this matter. I most emphatically think there should be considerable difference between a residence organ and church or concert organ. On the other hand, in Mr. Henry Willis' mind there is apparently no distinction to be made. An organ is an organ to Mr. Willis. A good organ is one on which the compositions of Bach can be satisfactorily played. What more can one want? I think when it comes to a residence organ one can want a great deal more.

In the following, I shall attempt to show that there are at least three schools of thought, when it comes to the tonal design of a residence organ: 1. To design it precisely like a church organ, and consider only the idea of playing true organ music upon it. 2. To design it to take the place of an orchestra, in interpreting chiefly orchestral music. 3. To compromise, and design an organ that will be reasonably satisfactory for any kind of music that might conceivably be played on an organ, with about equal consideration to ensemble and solo effects.

Considering plan number one, let us see what Mr. Willis suggests along this line.

In the March, 1929, issue of "The Rotunda," Mr. Willis writes an article which he entitles "A Model Organ." An organist friend of his, who he says is a very eminent organist, and himself put together and boiled down a scheme with a limit of some 30 stops which they submitted as a model residence organ scheme. Both of them being purists, all manual extensions were barred absolutely, and it was taken for granted that only one 16′ of full length could be accommodated. The specification they developed is reproduced below. In justification for this scheme, Mr. Willis has the following to say:

"The Great Organ is certainly as small as it could be—too small if anything—yet we have a twin Diapason Chorus (Bourdon, Open 2, Gemshorn: Open, Octave, and Fifteenth)—a soft Open Flute and a Tromba: surely not so bad! For the Swell we have a scheme which, on the face of it, combines good variety with a classical build up, the Mixture (12, 15, 19, 22) taking its logical place in the ensemble and completing it in the absence of a Clarion, the Twelfth being included in view of the absence of an independent Twelfth on the Great.

"The Choir may appear an unduly ample one for a small organ—yet what is there that is redundant? Nothing to my way of thinking. The Mutations—Nazard and Tierce—were absolutely essential to our

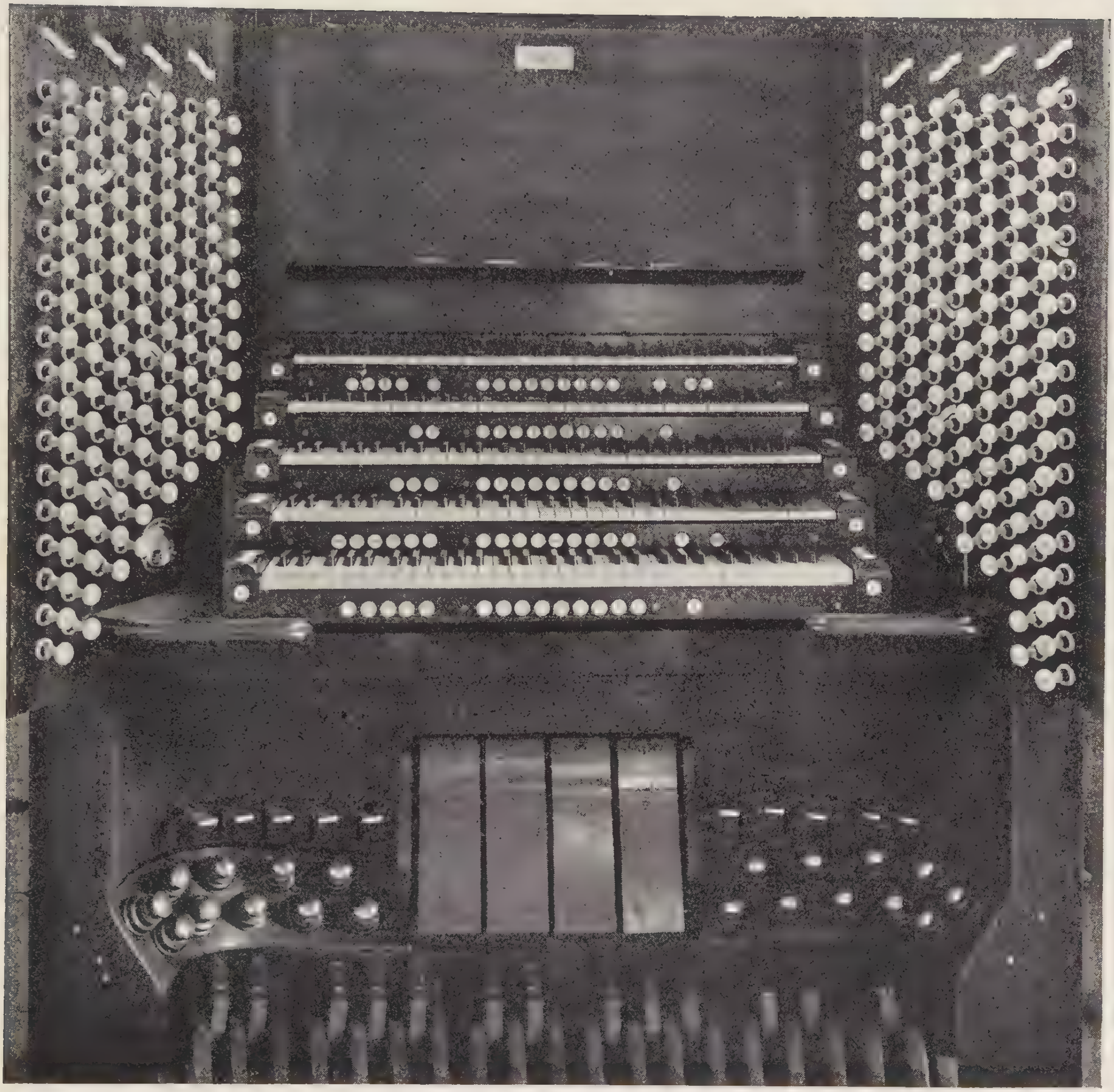


Plate XVIII.

Liverpool Cathedral console. The photo from which our plate was made is from the excellent collection by Mr. Gilbert Benham. Stop-knobs are grouped, from left to right, in vertical rows: Swell, Bombarde and Echo, Choir enclosed and unenclosed, Couplers. Right side: Couplers, Solo (enclosed String tone, and unenclosed), Great, Pedal enclosed and unenclosed. In addition to the groups of nine Pistons centrally located under the respective manuals, and the Adjuster to the right of each, there are the Bombarde On and the Echo On, under the Echo treble, and the Solo Trombones to Great under the Great treble.

minds coming before the erstwhile 'indispensable' Clarinet.

"The Pedal is naturally restricted by the fact that only one full-length 16 ft. is permitted, and also that the 30-stop limit had to be borne in mind: in the 'count' purely derived stops having no pipes are not counted. Only one real Pedal stop is provided, the Contra Bass, to be of heavy and even pungent tone of weight and precision, the balance of stops being made up of suitable derivation from or extension of the Manual stops, with reasonable Pedal extension.

"The lavish supply of couplers and pistons will not surprise those acquainted with recent progress in that direction."

This scheme was sent to various organists and organ builders, not only in England but in France and America, and their comments are printed in part in "The Rotunda."

The premise upon which this organ was designed was, "that it should be capable of playing all true organ music, enabling the composer's ideas to be brought out, and giving a real tonal balance and ensemble." In this, I presume, it succeeds quite admirably. This seems a very limited use to make of a residence organ.

It is furthermore inconceivable to my mind how an artistic residence organ could be built with a Great entirely unenclosed. Any of the arguments the unenclosed Great enthusiasts may make certainly do not apply in the case of a residence organ.

Turning from this scheme to perhaps the other extreme, I am submitting a typical Skinner residence organ scheme that is installed in a large residence in Minneapolis.

Here the premise was to build the smallest organ upon which all orchestral transcriptions could be performed with the greatest amount of fidelity and effect. There is no attempt at building up an ensemble in the organ sense of the word, and therefore the one Diapason present is of small scale. But the variety of Solo Reeds present is extraordinary for an organ of only 12 sets of pipes and the idea of enclosing the Great Organ in two separate chambers in the most effective manner possible (as a study of the specification will reveal) is most ingenious. The entire Great Organ is duplexed and playable from the Swell keyboard. There is no independent Pedal stop, but three extensions and two unit Flutes.

I wish to commend this scheme most heartily as being one of the most effective residence organs for the number of actual sets represented that I know anything about, particularly for the automatic player. I listened to this organ for several hours, and heard many of the finest symphonies by Franck, Tschaikowsky, Goldmark, and others, reproduced with a most uncanny fidelity and effectiveness. I would not have believed it possible had I not heard it with my own ears. This scheme, by violating practically every English tradition and every possible principle of soundness of design which Mr. Skinner insists on in his church organs, is most extraordinarily successful as a residence organ, for playing orchestral transcriptions. Mr. Skinner states a residence organ is "something else again" from the church organ, and certainly demonstrates it in this instance and with a great deal of justification. It seems curious that Mr. Willis does not recognize some of the purposes for which it is desirable to use a residence organ, instead of designing simply a fair-sized three-manual church organ of the most solid and conservative type. He further limits himself seriously by lack of any unification, and thereby has 30 sets of pipes with one solo reed. This can only be accounted for by the fact that he has been schooled in the traditions which Mr. Meyrick-Roberts so ably expresses, given in the quotation above.

Mr. Willis writes me most enthusiastically of the success of this organ which has actually been built for a residence in England, and so he and his client must be satisfied with it. If an American organ builder were to build a residence organ of 30 sets of pipes without Chimes, Harp, or Vox Humana, and with only one solo reed, he would probably be thought to be insane. But traditions are traditions, and soundness of design cannot be escaped, apparently.

We come now to the scheme of the residence organ in my house in Evanston which, to the minds of several hundred organists who have either heard or played it, combines most nearly the requirements of both Mr. Willis and that other large group of musicians who consider that orchestral transcriptions are very desirable on a residence organ. There are enough sets of pipes in this organ to make a complete ensemble on both the Great and Swell Organs with a very complete Pedal Organ. There are also available all the orchestral wood-wind and brass necessary for orchestral transcriptions. This organ contains 28 sets of pipes and is, therefore, almost exactly comparable in size to Mr. Willis' scheme. I submit it as a scheme having vastly greater usefulness and variety (and also much more artistic, being entirely enclosed) than the scheme Mr. Willis considers ideal.

A large part of this additional variety was secured by not wasting valuable space in having independent sets of pipes for all the 4′, 2 2/3′, and 2′s; and yet the tonal balance is not in any way upset. The dominating tones in the full organ are the two Diapasons, Octave, and the two chorus reeds, Trumpet and Tuba. These 5 sets of pipes, with the extensions of the Tuba, produce a fine ensemble alone of great power and dignity. There is a great variety of flutes; Doppel, Stopped, Claribel, Chimney, Spitz, Concert, and ample Strings for orchestral use, and all the Solo Reeds one can desire.

This scheme has been developed only by determining in actual use what was most desirable and effective in a residence organ. It is submitted as being the best compromise I know of between the austere, though completely sound, English scheme of Mr. Willis, and the almost purely orchestral scheme of Mr. Skinner; and it seems evident that the truth must lie somewhere between these two extremes.

This ought to give ample food for thought on the residence organ for some time to come.

THE WILLIS SCHEME

PEDAL:

32	Sub Bass Resultant
16	Contra Bass m
	Bourdon (Great)
	Quintaten (Swell)
8	Contra Bass
	Bourdon (Great)
4	Bourdon (Great)
16	Waldhorn (Swell)
	Trombone (Great)

GREAT: UNEXPRESSIVE

16	Bourdon sw
8	Diapason 1 m
	Diapason 2 m
	Clarabella w
4	Octave m
	Gemshorn m
2	Fifteenth m
8	*Tromba (heavy wind)
	*In Choir Chamber

SWELL:

16	Quintaten sm
8	Geigen Diapason m
	Aeoline m
	Voix Celeste m
	Rohrflöte swm
4	Viola m
	Flauto Traverso m
IV	Mixture 12-15-19-22
16	Waldhorn
8	Trompette h.t.
	Oboe

CHOIR:

8	Violoncello m
	Sylvestrina m
	Hohlflöte w
4	Flute Couverte sm
2 2/3	Nazard sm
2	Piccolo wm
1 3/5	Tierce sm
8	Tromba (Great)

THE MINNEAPOLIS SCHEME

PEDAL:

16	Bourdon
	Gedeckt
8	Flute
	Flauto Dolce (Gedeckt)
16	Trombone

GREAT AND SWELL: Duplexed

CHAMBER 1:

8	Diapason 1 61
	Concert Flute 61
	Flute Celeste 2r 122
4	Flute (Concert Flute)
8	Harp 61b

CHAMBER 2:

16	Gedeckt 97
8	Voix Celeste 2r 122
	Chimney Flute (Gedeckt)
4	Flute (Gedeckt)
2 2/3	Nazard (Gedeckt)
2	Piccolo (Gedeckt)
8	French Horn 61
	English Horn 61
	Clarinet 61
	Trumpet 61
	Vox Humana 61
	Chimes 20t

THE AUTHOR'S SCHEME

RESIDENCE OF MR. AND MRS. WILLIAM H.
BARNES AT EVANSTON, ILLINOIS

Console by Austin, chests by Moller, crescendo shades by Casavant. Mr. Barnes "assembled this organ from the work of the builders listed; much assistance was received in assembly and construction from Mr. Dan S. Wentz of the Moller company." The following manufacturers and builders are represented as indicated by initial letter in the stoplist:

A—Austin Organ Co.
D—J. C. Deagan Inc.
E—Dennison

G—Gottfried
H—Hall Organ Co.
J—Johnson
K—Kohler-Liebich Co.
L—Kimball Co.
M—M. P. Moller
N—Meyer
O—Odell
R—Roosevelt

PEDAL:

32	Resultant f (Bourdon)
16	Diaphone f 32 (L)
	Salicional p (Swell)
	Bourdon mf 44 (M)
	Bourdon pp (Great)
8	Bourdon mf
16	Trombone ff (Great)

GREAT:

16	Bourdon p 97 (H)
8	Diapason f 61 (M)
	Doppelflöte mf 61 (G)
	Bourdon p
4	Octave 61 (R)
	Bourdon p
2 2/3	Bourdon p
2	Bourdon p
1 3/5	Bourdon p
16	Contra Tuba ff
	French Horn mf
8	Tuba ff 85 (L)
	French Horn mf 73 (G)
	Trumpet ff 61 (L)
	Clarinet mp 61 (G)
4	Tuba ff
8	Chimes 20 (D)

SWELL:

16	Bourdon p (Great)
8	Diapason f 73 (H)
	Viole d'Orchestre mf 73 (G)
	Viole Celeste mf 61 (G)
	Muted Viole pp 73 (G)
	Unda Maris pp 61 (J)
	Claribel Flute mf 73 (A)
	Bourdon p (Great)
4	Muted Viole pp
	Bourdon p (Great)
	Chimney Flute p (O)
2 2/3	Bourdon p (Great)
2	Piccolo p 61 (N)
1 3/5	Tierce p 61 (N)
8	Cornopean f 73 (A)
	Oboe mp 73 (H)
	Vox Humana p 61 (E)

There is a synthetic Orchestral Oboe, drawn from the Viole d'Orchestre and the Tierce.

ORCHESTRAL.

16	Contra Salicional mp 61 (L)
8	Gamba mf 61 (G)
	Dulciana pp 73 (G)
	Concert Flute mp 73 (M)
	Spitzflöte p 61 (G)
	Flute Celeste p 49 (G)
4	Dulciana pp
	Concert Flute mf
8	Cor Anglais mf 61 (G)
	Harp 49b (K)
	Vibra-Harp 49 b (D)

TONAL CHARACTERISTICS OF THEATER ORGANS

The theater organ has evolved along the lines suggested by Mr. Hope-Jones. The typical theater instrument is highly unified. A few builders designed such organs along more conservative and orthodox lines, though featuring numerous orchestral voices. Unfortunately, such examples were not appreciated by the theater owner and they have now nearly all been superseded by the unit organ, even though they were obviously more artistic. Experienced theater organists have been trained to prefer a highly unified organ for the effects they require.

My experience with theater units is like that of the majority of the American public—merely to listen to them. To my ears, the larger units are capable of some very lovely solo effects but the general results are far from really artistic.

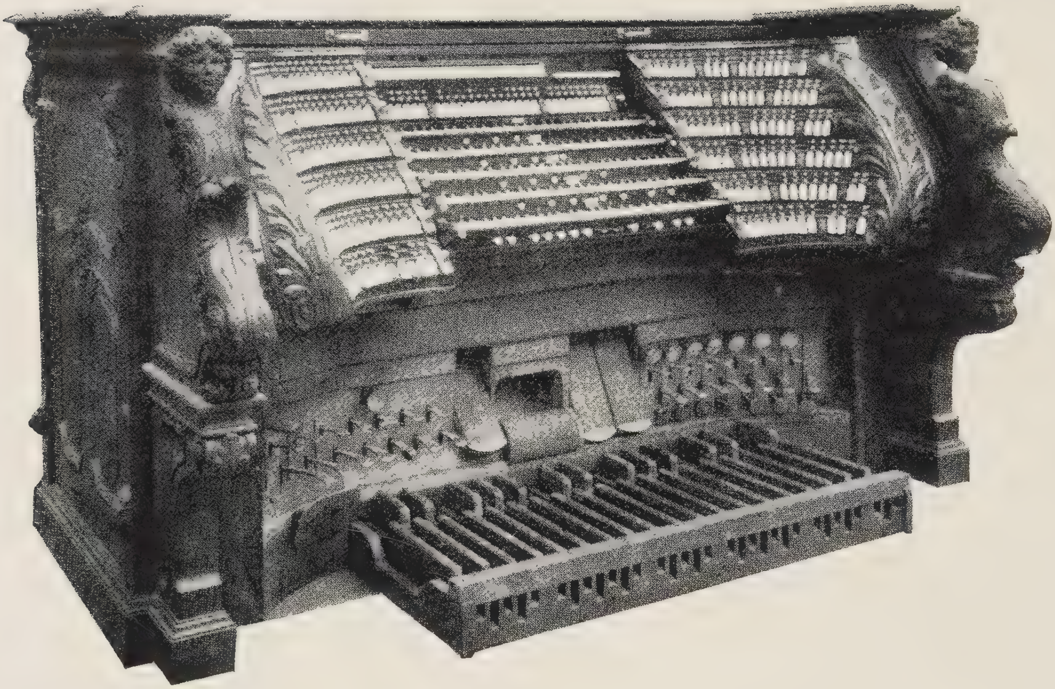


Plate XIX.

St. Michael's, Hamburg. This console controls the largest organ in Germany. Note the old fashioned, flat pedal board which is still used in Germany. The register crescendo is operated by means of the large roller or drum immediately above the pedal keys. It is difficult to imagine why this arrangement should be more convenient than the ordinary register crescendo pedal. The large number of stop controls are conveniently disposed in somewhat elliptical fashion. The stop controls are a form of rocking tablet. The builder of this console, Walcker, has used a modern pedal board on the console for the Barcelona Fair organ.

The basis of the typical unit scheme is a big hooting Flute, usually the Tibia Plena or Tibia Clausa. Without this stop and a sobbing tremolo the *piece de resistance* of the theater organist would disappear. Next comes the Vox Humana, and then a pair of keen Strings. After this a milder Flute and softer String will be in order. These softer registers are unified all "over the place," at all pitches on all manuals. The heavier toned stops are also unified liberally. When perhaps six stops have been provided of the more essential qualities for the theater organ, a Diapason of some kind may be considered. This will usually be of smooth, flutey character. Then a Chorus Reed. Synthetic stops, produced by a combination of the unison and one or more of the mutation pitches of the soft Flute, or by means of the unison pitch of the keen String combined with the 12th or 17th of the Flute, are introduced in lieu of solo Reeds in the smaller units.

The organ just outlined is a fair specimen of the small theater unit. It will not ordinarily exceed eight ranks of pipes. Such an organ is habitually advertised by the theater owner as costing from $20,000 to $50,000 in accordance with his estimation of the gullibility of the public. In reality, its cost should not exceed $10,000. The highly inflated advertised values of theater organs and the general air of mystery surrounding them has given the public false and exaggerated impressions of the true value of the theater unit among really musical instruments.

In spite of the theater organ's striking defects, the demands of the theater organist for excessive speed in the key, stop and expression pedal action in the organs they play, have resulted in improvements in all classes of organs mechanically. In this respect such organs have contributed to the art of organ building. The theater organ is responsible, at least indirectly, for many valuable mechanical improvements, though when viewed from the standpoint of legitimate organ design, it may be said to be a "total loss."

Larger examples of this class include more solo Reeds and usually another big Flute. The largest ones seldom exceed twenty sets of pipes. The Roxy Theater in New York and the Chicago Stadium are two exceptions. Both of these contain approximately fifty ranks. The latter has been advertised as the "largest organ in the world." As a matter of fact there are probably one hundred larger throughout all parts of the country, though perhaps none louder.

In all theater units, in addition to the pipes we have enumerated, a feature nearly as important is the "traps" and percussions. Harp, Chimes, Glockenspiel, Sleigh Bells, Wooden Marimba, Xylophone, and similar devices are common. The "traps" include Bass Drum, Snare

Drum, Chinese Block, Gong, Sand Paper, Bird Calls, Taxi Horns. Thunder and Air Plane Noises, Locomotive Whistle, and other effects. Good theater organists have learned to make highly ingenious, and even artistic use of some of these percussions and "traps." They certainly add variety even if they are not strictly speaking organistic.

Another important difference between theater organs and the more legitimate variety lies in the manner in which the tonal forces are enclosed. The straight organ normally has each manual division enclosed in a separate expression chamber. With the unit scheme, where no stops have a "home" manual to which they really belong, it is customary to enclose pipes by families of tone. Large units may have four separate enclosures, causing such an organ to be flexible and expressive to a greater degree than the straight organ. Such a method of enclosure was originated by Mr. Hope-Jones.

It is not my intention to be unsympathetic in describing theater units, but certain features, particularly the hyperbole, to use a mild word, that is habitually used in describing their virtues as well as their cost by the theater owner is a bit annoying. I find it also annoying to listen to them, unless they happen to be played by a real artist, of which there may be half a dozen in the entire country. I have endeavored, in spite of this to give a fair presentation of the chief characteristics of such organs. The maximum variety of solo effects for a given number of ranks is the principal end and aim in such instruments.

A large unit organ that has the saving grace of a real ensemble as well as numerous solo effects is the one designed by Senator Emerson L. Richards in the Atlantic City Convention Hall Ball Room. Mr. Richards has provided here a real Reed Chorus as well as a twin Diapason Chorus in addition to all the material that can delight the heart of the theater organist. This organ is therefore a most useful instrument, as it will satisfy both concert and theater players.

The tonal content of this organ is presented below. It should be noted that in common with all unit organs, the majority of the voices in this scheme are available at several pitches on the Pedal and each of the manual divisions, though these various derivations are not listed. To do so would require several additional pages.

ATLANTIC CITY, N. J.

CONVENTION HALL BALL ROOM

W. W. KIMBALL CO.

Unit organ designed by Senator Emerson L. Richards.

SUMMARY

V 42. R 55. S 288. P 4139.

6 Percussion. 11 Traps.

Pedal: 39 stops; Second Touch for traps

Accompaniment: 53 stops; S-T 14.

Orchestral: 71 stops; S-T 14.

Solo: 61 stops.

Bombarde: 36 stops.

Total First Touch: 260 stops.

Total Second Touch: 28 stops plus traps.

CONTENT

Data included in this order of mention: number of pipes, wind pressure, scale

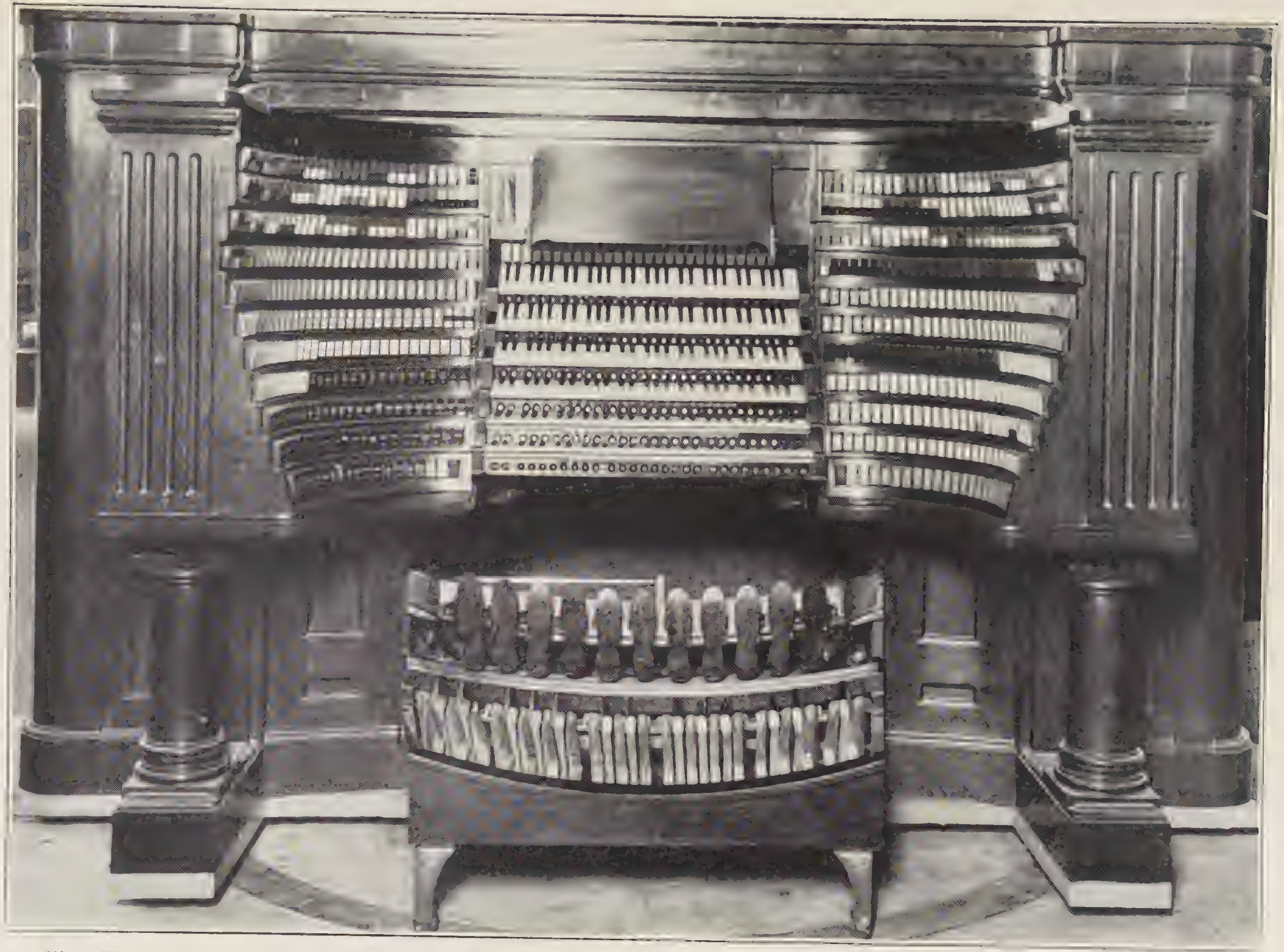


Plate XX. Unique console of the largest organ in the world in the Wanamaker Grand Court, Philadelphia. Designed by Charles M. Courboin and built in the Wanamaker Shops, under the supervision of George Till and William Fleming

*Indicates pipe-work in the left chamber, all other in the right.

32 Bombarde 97 25″ 15″
16 Tuba 97 25″ 11½ x 11½
*Diaphone-Phonon 85 15″ 14x14
*Trumpet 85 15″ 7½″
Post Horn 85 15″ 5½″
*Oboe Horn 85 10″ 5½″
*Tibia Clausa 97 10″ 11½x9½
*Stopped Flute 101 10″ 7⅛x6
Viola Diapason 85 10″ 36
*Violin 97 10″ 48
8 Diapason 85 15″ 41
*Clarabella 85 10″ 5½x6¾
Flauto Dolce 85 10″ 47
*Gemshorn 85 10″ 46
Clarinet 73 10″ 1 15/16
*English Horn 61 10″ 5″
*Kinura 61 10″ large
*Vox Humana 73 10″ large
Cello 73 15″ 53
Cello Celeste 73 15″ 53
*Violins 2r 73 10″ 60
*Viola 85 10″ 55-59
*Viola Celeste 73 10″ 55-59

Straight
8 Diapason 73 10″ 39
*English Diapason 73 10″ 43
*Muted Diapason 73 10″ 40
*Melophone 73 10″ 6⅝x7⅝
Flute Ouverte 73 10″ 40
Flute Celeste 73 10″ 47
Gemshorn Celeste 73 10″ 46
Brass Trumpet 73 15″ 6½
Saxophone 73 15″ 2½″
French Horn 73 15″ 7½″
Orchestral Oboe 73 15″ 2½″
*Orchestral Strings 2r 134 10″ 63
*Orchestral Strings 2r 134 10″ 66
*Muted Strings 2r 134 10″ 60-76
4 Major Octave 73 10″ 52
*Octave 73 10″ 53
2 Major Fifteenth 73 10″ 65
VII Grand Mixture 511 10″
12-15-17-19-22-26-29
V *Mixture 305 10″
15-19-22-26-29

Percussion:
Piano
Celesta
Xylophone
Glockenspiel
Chimes
Vibra-Harp

Traps:
Bass Drum, Cymbal, Snare Drum, Chinese Gong, Castanet, Tambourine, Wood Block, Tom-Tom, Triangle, Birds, Sleigh Bells.

ACCESSORIES

Couplers: 24 First Touch, 2 Second Touch.
Tremulants: 7.
Crescendos:
Right Chamber
Left Chamber
Register
Combination Pistons: 48.
8 for each manual division, the Pedal 8 being operated on the Second Touch of the manual pistons.
Tutti Cancel.
Piano Sostenuto on Second Touch of the Pedal Keys
Tremulant Cancel.
Traps Cancel.
Crescendo Coupler.

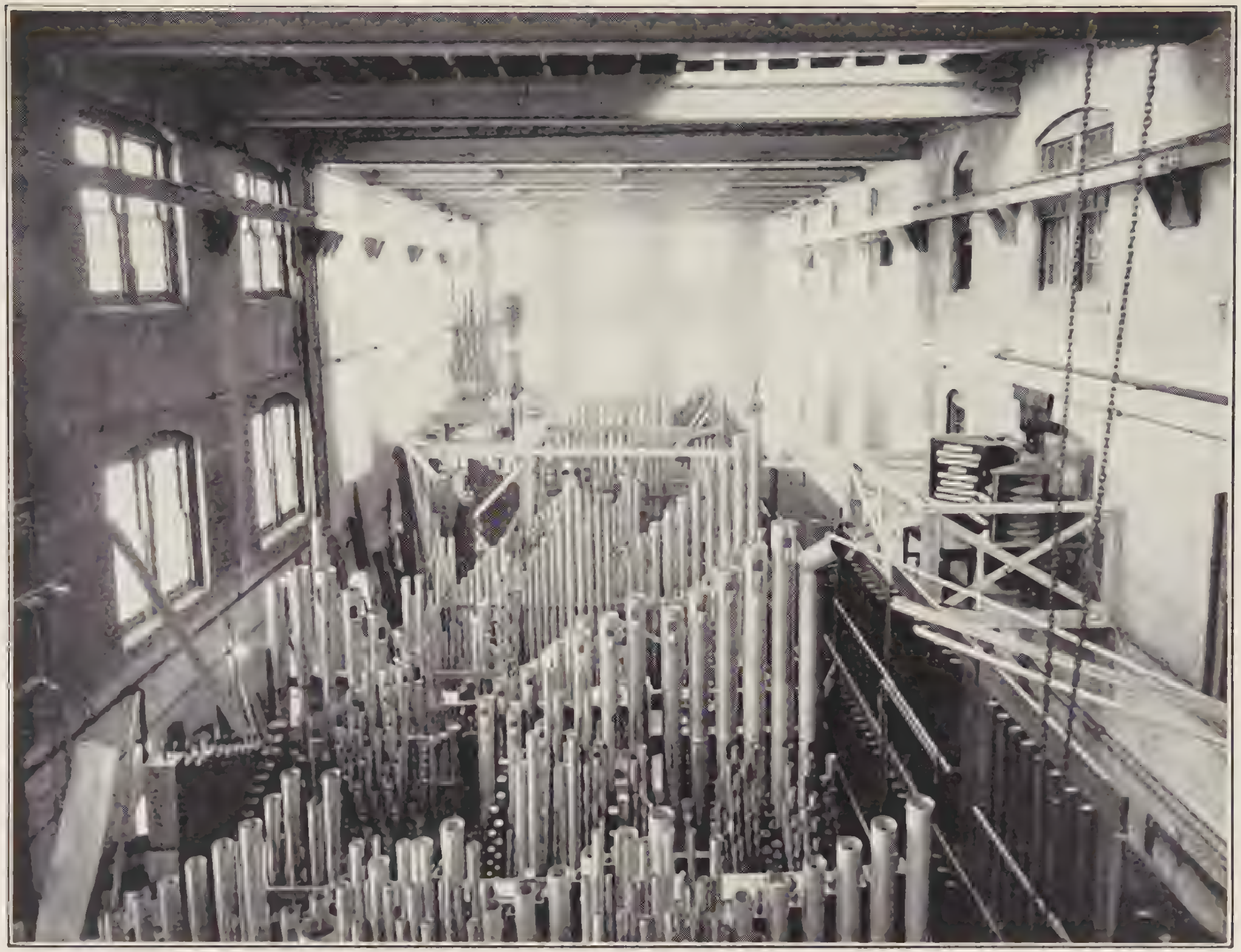


Plate XXI.

Parts of four sections of the Pierre S. duPont organ (three other sections not shown) with console in testing position. Each expression chamber is a room with masonry walls, sound insulated. Aeolian Company, Builders.

CHAPTER 13.

TRANSFERENCE *of* STOPS

"UNIFICATION"

UNDOUBTEDLY, one of the most highly controversial questions in present day organ building in America is the one relating to the subject known as "unification." There have been endless arguments for and against "unification" published in "The Diapason" and the "American Organist" for many years past. The matter does not appear to be any nearer a solution than it was some years ago, though some of us may have changed our ideas in the meantime.

Before taking up the subject of "unification" and defining what we mean by this term, we shall take up the simpler matter of the transference of stops from one keyboard to another.

Until the introduction of the tubular-pneumatic action, it was seldom if ever possible to play a stop or set of pipes belonging to the Swell Organ, for example, on the Great Organ independently, and without the use of couplers. By means of a system of double stop action (which is described in our various chapters on organ action in detail), it is possible to play any or all sets of pipes perfectly independently on either one or both of two different keyboards. This plan should never be used simply in an effort to make an insufficient number of stops suffice for a large building. On the other hand, such a plan in the case of a small organ, or even in larger organs to render certain stops available independently, on more than one keyboard, is frequently of very great advantage in adding to the number of tonal effects that are possible. No argument can be advanced that this practice can in any way upset the tonal balance of the organ, or in fact affect the full organ in any manner whatever. It is merely a plan for placing the tonal resources at the most convenient disposal of the organist.

Hope-Jones is usually credited with having developed this plan of transference of stops or "duplexing," as it is commonly called. Mr. Skinner refers to the idea as rendering a particular stop "interchangeable" between two manuals. So much then, for the plain duplexing of stops between manuals. To adopt such a plan certainly involves no artistic violations of any sort in the tonal scheme of the organ, but rather makes the limited resources of a small organ available to greater advantage. The only possible question of the advisability of this procedure that can be raised is whether the additional cost of the mechanism involved in doing this duplexing is worth as much or more than the additional pipes that might be purchased with the same amount of money. This is a matter for the designer of the organ to determine, when all the circumstances of the installation are known.

Coming now to the really controversial matter of unification. Originally this term meant a scheme of treating the entire organ as a single unit and making it possible to draw any or all of the stops on all of the keyboards at any reasonable pitch. This plan was originally announced before the Royal College of Organists in London by Hope-Jones at his lecture delivered on May 5, 1891. Unification now may mean that only one or two sets of pipes in an organ are so treated.

Mr. John Compton, the eminent English organ builder, has apparently been about the only one in England to follow along the lines that Hope-Jones suggested. Mr. Compton is not only a voicer of organ pipes of the highest excellence, but an organ builder of extraordinary resourcefulness and skill. There is no question in my mind that if unification is to be extensively adopted in a church organ, the examples Mr. Compton has produced in England, as for instance in the Liberal Jewish Synagogue, London, are the finest of this type of organ in existence. Without a doubt the organ in this latter church is the most remarkable organ of twenty sets of pipes that I have ever heard. This organ is further described in our chapter on Specific Examples of Good Tonal Design.

At this point, it should be observed that there is likely to be a certain amount of confusion in the minds of some organists as to the distinction and very real difference that exists between a unit organ and a straight organ with one or more unified stops.

A true unit organ has its registers available at practically all pitches on all keyboards, including the pedal, and therefore needs no couplers in the ordinary sense. The various sets of pipes have no "home" manual to which they belong. The organ with *some* unified sets is a regular orthodox straight organ for the most part with one or more stops available at various pitches, on perhaps, more than one manual and pedal, but with the unified stops having a definite "home" manual to which they really belong. This is important to realize. Controversy arises when a few unified sets of pipes are introduced in an otherwise straight organ scheme, because organists are not clear on this point. As soon as the term "unit" is mentioned to them, they think of the completely unified theater organ and make no allowances whatever for the unfinished and crude voicing that prevails in many theater organs. This combination is manifestly unsuited to church use and has been since its inception. On the other hand, a few soft unified voices do not destroy tonal balance or ensemble, but add additional color and flexibility. In truth, a great deal depends on the man at the console.

So far as I know, Henry Willis in England, the Skinner Organ Company and Casavant Freres in this country are builders who are such "Purists" that they are unalterably opposed to unification of any sort in a church organ and have steadfastly refused to follow this practice in even a limited way. I know of no other American organ builders who have not, at one time or another, and in the case of some, made a practice of unifying at least one or more stops. It has become nearly a universal custom in American building, sometimes rightly and more often wrongly employed.

I think we may grant at the outset, that, if space and money are ample, every artistic organist prefers the so-called straight organ, where every stop is represented by its own set of pipes, individually scaled and voiced to a nicety, to maintain a true balance and relation between the 16 and 4 foot registers and the 8 foot. There scarcely can be any argument about this. Unifying should never be adopted in any form under these conditions. It is at best a compromise between insufficient 16′ and 4′ and other registers not at unison pitch, or an ample supply of these registers when unification of certain 8′ registers is adopted. In the very nature of things, these derived stops cannot exactly duplicate independent pipes.

The difficulty is, that in a great majority of cases neither space nor funds are ample, and it then becomes a serious question as to the best course of procedure. It must be obvious that twenty sets of pipes will require less room than thirty, and, if an organ of twenty sets is partly unified, it will have approximately as many tonal effects as that which may be obtained from thirty or more sets where they are all "straight" stops. "Approximately" is the correct word to use, as the effect will, of course, not be exactly the same. In our chapter on The Tonal Design of the Organ, we discussed at length an organ ensemble and how it is secured. A good ensemble is one of the most characteristic and desirable virtues a church organ may have. It is not important in a theater organ and not so important in a residence organ, though quite desirable. It should, therefore, be apparent that no stops should be unified, particularly in a church organ, that are going to tend to upset the tonal balance or create an imperfect ensemble. If the unifying is confined to only soft registers, such as Dulcianas, small scaled Flutes, and Gemshorns, and possibly a very soft mild String, then it is inconceivable that the ensemble of the organ will in any way be injured by such practise. When the more powerful toned stops are drawn, the tone of these lighter stops will be entirely swallowed up and practically inaudible, so what is done to them is of no consequence in the ensemble.

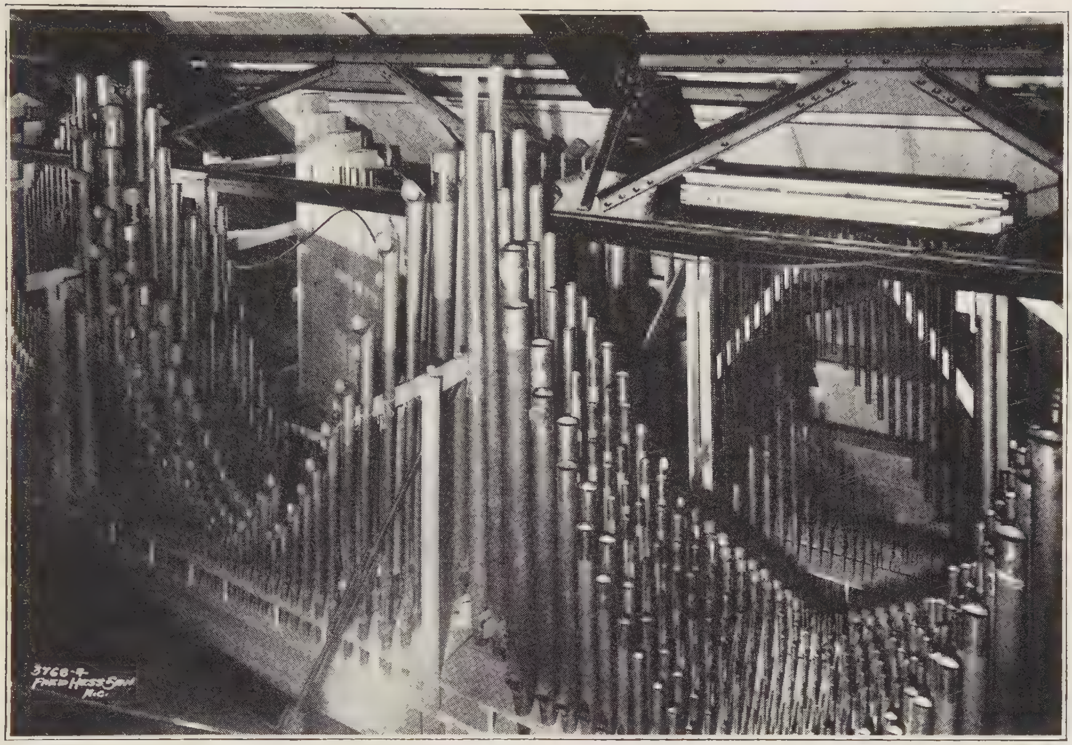


Plate XXII.

A view of the Echo Division of the organ in the Atlantic City Auditorium. This division is placed between the roof trusses of the mammoth building and speaks into the auditorium through a large grille high in the ceiling. Unfortunately, the main portions of this gigantic organ were not sufficiently advanced at the time of publication of this book to obtain photographs. This organ will be epoch-making in many directions. The portions already finished afford some idea of the magnificent scale on which everything is being done by the Midmer-Losh Co., under the able direction of Senator Richards.

Where unification is extended to powerful stops, such as Diapasons (even to the second Diapason on the Great Organ), or Chorus Reeds, such as Trumpet or Tubas, or large scaled Flutes, the ensemble is likely to suffer more. Even this faulty use of unification is practiced extensively. When unification is attempted intelligently and with discretion, it is not objectionable and permits of much greater tonal variety, even though it is freely admitted that such extended stops are not as good as independent pipes.

In reality, all that unification consists of, as applied to a single stop, is to furnish that stop with independent and individual octave couplers. Why it should be considered so inartistic and reprehensible to apply octave couplers to various stops individually, rather than being compelled to couple all the stops in use on a whole manual by means of the regular octave couplers, has never been quite clear to me. It is frequently more artistic and desirable to couple only one or more stops on a keyboard at 4′ or 16′, than to couple all the stops on the particular keyboard that happen to be drawn at 16′ and 4′ as when the regular octave couplers are used.

Probably one of the chief objections to unification of the more powerful stops is, that the octave couplers are caused to affect stops that are already played individually at octaves, thereby in effect creating a coupler which plays this stop two octaves above unison or two octaves below unison or even greater extremes from the unison pitch, in cases where the stop is unified at more than three pitches (a common practice). This has the effect of upsetting the tonal balance of the organ seriously and makes the ensemble appear to have all top and bottom and no middle. Such inartistic use of unifying stops has been one of the chief reasons for their condemnation by artistic organists and builders. But organists should know more of the mechanics and should never fall into such traps—their ears alone could show them that the effect is wrong.

No such objection can be advanced in the case of the softer toned stops recommended. If bolder toned stops must be unified, they should preferably not be affected by the regular octave couplers of the organ.

Unit stops, to be really successful, properly should diminish in power towards the top and increase in power toward the bottom, a condition which is almost the reverse of what obtains in the case of a stop used at one pitch only. If the bass of the unit stop is to be available on the pedal (as is nearly always the case), or otherwise the cost of unifying is not justified, it must necessarily be heavy in the bass portion to make a suitable pedal stop. Particularly the bottom octave must be heavy if the stop is of any great power on the manual. It is not desirable to have

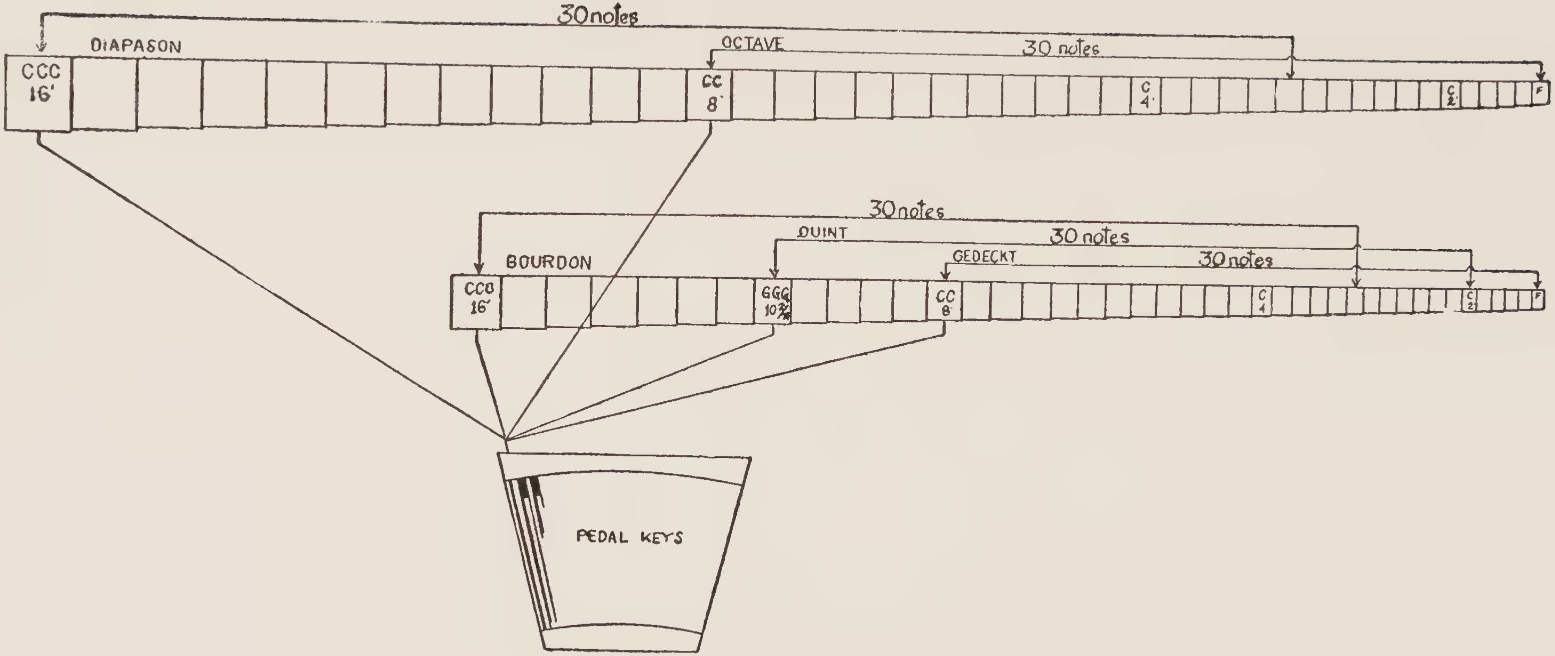


Figure 43.
The "Augmented Pedal." (From Skinner, "The Modern Organ.") The pedal compass is now 32 notes, but the same principles apply.

the four foot octave of a Flute as powerful as the eight foot unison tone and, therefore, the stop should decrease in power upwards. A unit stop, therefore, is somewhat of a hybrid or composite in scale and power when most artistically developed. These difficulties are not encountered in the case of soft toned stops, as already suggested, as they may be kept approximately the same strength throughout the compass without any modification, with reasonably good results.

Another type of duplexing that is very useful in some ways is that which is employed to make the same set of pipes available at octave and unison pitches or sub-octave and unison pitches on the same manual. Also, if a duplex chest is provided, a stop may be played at unison pitch on one manual and an octave higher or lower on the other. This can be accomplished with small expense and little mechanism as compared with that required for the actual unifying of a stop, and is frequently more justifiable from this point of view than to adopt unification.

Unless a stop is going to be used at least four different ways, as for example, unison pitch, octave above, octave below and on the pedal, it does not pay to unify it. The cost of additional mechanism for such limited use is as great as it would be to put in individual pipes, which are always preferable when space is available.

In residence organs, unifying and duplexing may be resorted to freely. The Skinner Organ Company, in the case of their residence organs, frequently add two or more unit stops and much duplexing. The results amply justify them in doing this.

In theater organs, it is taken for granted that all stops shall be unified to a greater or less extent and this has become standard with this type of instrument. Here, ensemble is of small importance.

To sum up, if unification in a church organ is confined to soft and unobtrusive registers or, if extended to more powerful stops, and if these latter are not affected by the octave couplers, no injury to the tonal balance or ensemble will occur and considerable may be gained in flexibility and variety. Unification and duplexing may be adopted to a still greater degree in residence organs, with advantage, and it is standard practice in theater organs.

Another form of unifying though called by the euphemistic name of "Augmented Pedal," is almost universally practiced by American builders, as well as English. Mr. Skinner, in his work on "The Modern Organ," has this to say for the Augmented Pedal:

"The Augmented Pedal" is supposed by many, including a few organ builders, to be a makeshift or form of swindle intended to defraud the unwary. It is for this reason that the following explanation is given.

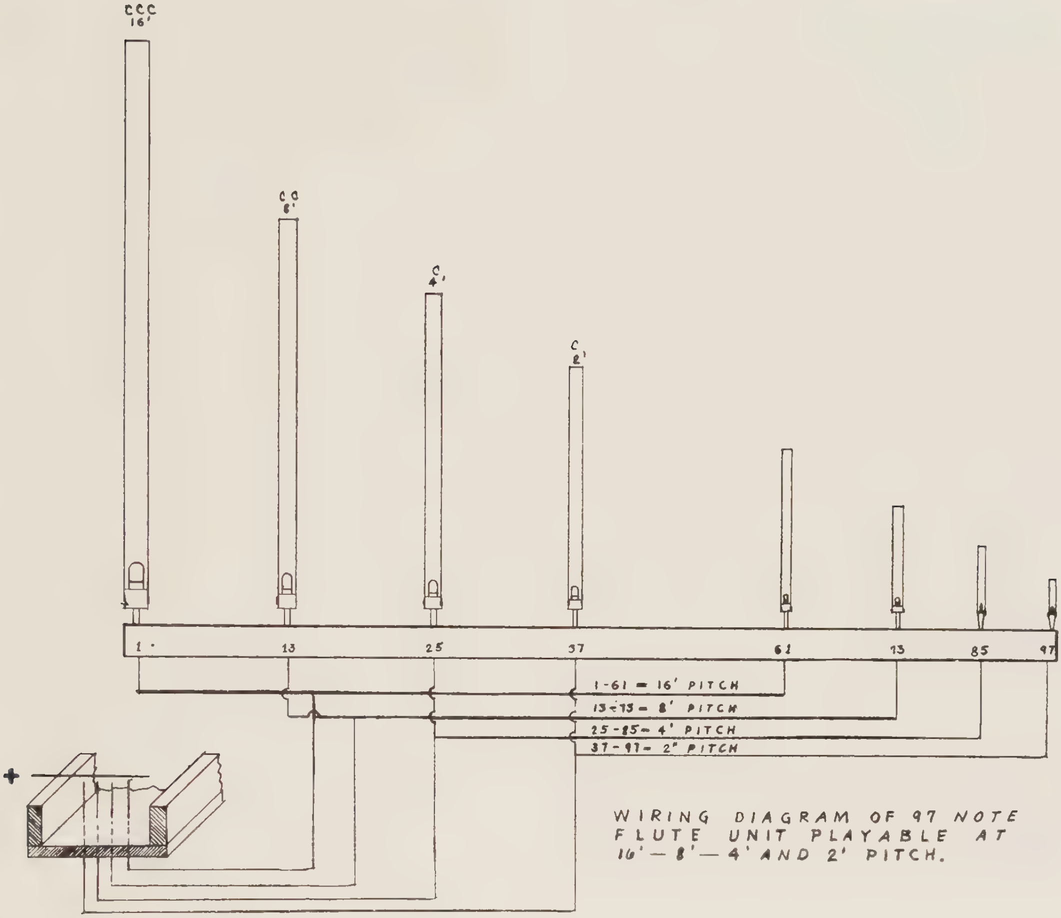


Figure 44.

A separate contact is required for each note that is obtained from a unit stop. Mechanism is increased and pipes are decreased in such construction, as will be seen by the above drawing.

The idea of the Augmented Pedal is not new. It originated in England and the idea is at least thirty years old, probably more.

It consists of a construction that permits of drawing the pedal stops at either sixteen or eight foot pitch.

There is a fundamental reason why this is good practice with regard to the pedal organ and radically wrong when applied to the manuals. The manuals are played in chords, the pedal idiom is one note at a time. In the common chord of "C" on the manuals, if a four foot stop be taken from an eight foot stop, there will be, if both are drawn, one "C" less sounding than if both stops were complete in themselves. In the event of larger chords, doublings and omissions are more pronounced. *This is, of course, the case with all manual octave couplers.*

With the pedal organ, the conditions are wholly different as chords are seldom played on the pedals. It is, therefore, clear that the effect of an eight foot stop is not discounted by any probable use of its sixteen foot relative. In the construction of the Augmented Pedal, all the stops to be augmented are carried one octave higher in order that the scale of the stops of eight foot pitch may be complete.

The italics are mine, and are important to observe, for nothing more serious happens musically when an octave coupler is applied individually to a certain stop, than when an octave coupler is applied to a whole manual. All builders and organists seem to be agreed in the liberal use of manual octave couplers, except on the Great Organ. Intelligently unified stops afford greater variety and choice in the use of octave couplers than the manual octave couplers provide. This furnishes their justification and *raison d' etre.* It must be observed that they cannot wholly take the place of additional pipes. Unification obviously cannot change or in anyway affect the tone quality of the pipes so treated, though some builders have endeavored to make the unwary purchaser believe it can, in some mysterious manner. If the time ever comes when organ purchasers have even rudimentary knowledge of organs, it will be impossible to put across such absurd ideas.

Figures 43 and 44 are diagrams showing the principle of the augmented pedal and a wiring diagram for a unit stop.

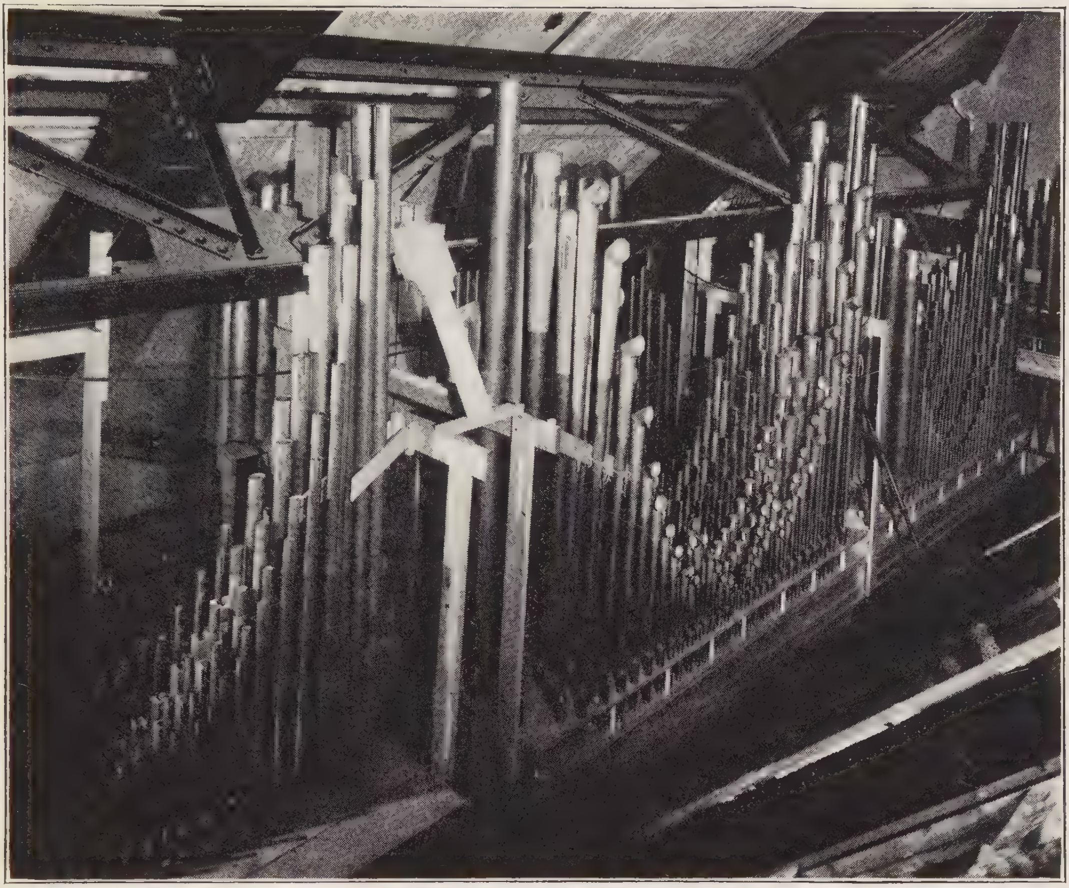


Plate XXIII.
Another view of the Echo Division of the Atlantic City Auditorium organ.

(See Page 189)

CHAPTER 14.

LOCATION *and* SPACE REQUIREMENTS *of the* ORGAN

ONE of the problems that the designer of an organ (usually the builder) nearly always encounters is that of getting the proper amount of space and the most advantageous location for the organ. As a rule, architects are glad to co-operate with the organ builder by providing adequate space for the organ, but unfortunately many architects do not know what is required. Frequently, the plans of the church are completed before the organ builder is called in, or any other person sufficiently versed in organ matters to advise with the architect of the church. In such cases, it is nearly always found that inadequate provision has been made for the organ and it frequently becomes difficult to make changes that could easily have been made had the architect been advised in advance. It is always desirable for those contemplating the building of a new church or other building in which an organ is to be placed to secure a competent adviser early in the proceedings to consult with the architect of the building as to just what is necessary. A great many mistakes and a good deal of unnecessary expense can thereby be avoided.

Having assisted in the design and layout of some fifty organs over a period of years, I can speak from considerable knowledge of this subject. I find that many architects are inclined to think that space that cannot be used for any other purpose in the general layout of the church, not even for wash rooms, or Preacher's study, choir rooms, or any other conceivable *useful* purpose, is assigned to the organ. Attic space, or space of awkward and irregular shape is frequently provided, that causes a great amount of difficulty to the organ builder in assembling the parts of the organ. This also causes very undesirable cramping and crowding of the speaking parts. After all, if an organ is worth building and worth paying for, it certainly seems only proper that it be given an opportunity to sound at its greatest efficiency.

Undoubtedly, one of the most ideal locations for an organ is that in which the instrument stands in the auditorium entirely open on all sides. Formerly, such installations were frequently encountered. Organs were placed in the center of the front of the church with ample speaking space on both the front, sides and top. This manner of placing the organ is fast becoming obsolete. Due to the general adoption of the Episcopal style of chancel, the organ is usually placed at one or both sides of the choir stalls. The ideal conditions, for this placing of the organ, is to have a shallow chamber of considerable width, and a large amount of height. An organ chamber of this general shape allows the instrument to be assembled so that no portion of it obstructs any other. When great height is available, one or more divisions of the organ may be placed on top of the other, perpendicularly, the Swell over the Choir, and Solo on top of the Swell Organ (in the case of a four manual organ).

This is not the most desirable arrangement, however, and should be avoided if possible. For the best results, all divisions of the organ should be on the same level, in order to avoid difficulty with tuning. It is almost impossible to keep the various sections of the organ in tune together when they are on various levels. The temperature of the church does not remain even, particularly in the winter time when the upper portions of the church heat more rapidly, causing these sections of the organ to be sharper in pitch than the lower sections, unless the organ happens to have been tuned under exactly the same conditions, which is not apt to be the case. When all pipes in the organ are on approximately the same level, they are usually found to be reasonably in tune with each other, even though the temperature is considerably above or under the point at which the organ was tuned. The ideal shape of an organ chamber is, "twice as wide as it is deep and as high as it is wide."

It is generally unwise when an organ is placed in a chancel location to open the side of the chamber towards the transept, particularly if the organ is divided on either side of the chancel. If this is done, people seated in a side gallery or transept will inevitably hear one side of the organ out of balance with the other, with very unpleasant effect. A divided organ should properly speak into the chancel from opposite sides, and allow the tone to have an opportunity to mix before it reaches the ears of the congregation. In any event, the best results from the organ are always obtained when its tone is directed towards the singers, so that the voices and organ tone are blended together, and do not come from disjointed and several removed locations.

In locating a residence organ it usually is a difficult matter to obtain sufficient space for even a small instrument on the same level of the room from which the organ is to be heard, unless a special addition is built to the house for a music room. Nearly every home has unneeded space in the basement, part of which can be very advantageously utilized for an organ chamber. It may be necessary to extend the depth of the basement floor for the part to be used to get sufficient height. Eleven feet is a convenient minimum in order to avoid mitering many of the longer pipes, though organs have been installed successfully with as little as eight feet in height.

The author has made two such installations of a residence organ, with good sized openings cut into the floor, immediately above a portion of the organ chamber in the basement. The expression shutters have been installed into these openings and the pipes stand directly beneath. This secures the most direct egress of the sound of the organ into the music room. It is, however, more customary to place the organ back of the tone openings and arrange the shutters vertically instead of horizontally, using the space beneath the opening simply as a tone chute. The idea of this is to prevent dirt and dust from falling through the tone openings directly into the pipes. This can be overcome by placing a screen of muslin directly below the openings, with excellent results, as I have demonstrated.

There is only one disadvantage in so placing an organ in a residence that I have discovered over a period of years' use. This is the problem of overcoming the effects of the excessive changes in atmospheric conditions that occur between summer and winter. These changes are hard enough on an organ when it is placed at ordinary levels. The dryness that prevails in winter causes considerable shrinkage in all the wooden parts and the dampness that is usual in certain months of the summer causes inevitable swelling of these portions. The organ can be adjusted for either dryness or dampness, but it will require further adjustments when these conditions change radically.

By attaching spring washers to the screws that secure all the portions of the organ where wind is likely to escape, if the screws become loose, one difficulty of extreme dryness is considerably obviated. In a basement installation, extremes of dryness and dampness are even greater than in ordinary locations and it may become necessary to humidify the air in some manner in winter, and to use an electric fan or other means of drying the air in summer to avoid too great extremes in atmospheric humidity.* When these precautions are taken, an organ will work quite as satisfactorily in a basement location as any other. Occasionally residence organs are installed adjacent to a staircase, but inevitably in such cases the large amount of room that an organ requires has to be provided in portions of the house that are less desirable or convenient to devote to such purposes.

Another method of installing a residence organ is to place it in the attic, allowing the tone to find an outlet by means of a grill in the ceiling and through a stair-well. Such installations are not as satisfactory, ordinarily, as basement installations, as a larger percentage of the tone is likely to be lost before it finds its way to where it is to be heard. It is usually a more difficult matter also to keep reasonably uniform tem-

---

*This happens to be the case in the vicinity of Chicago, due to the proximity of the lake. Other places may have similar conditions.

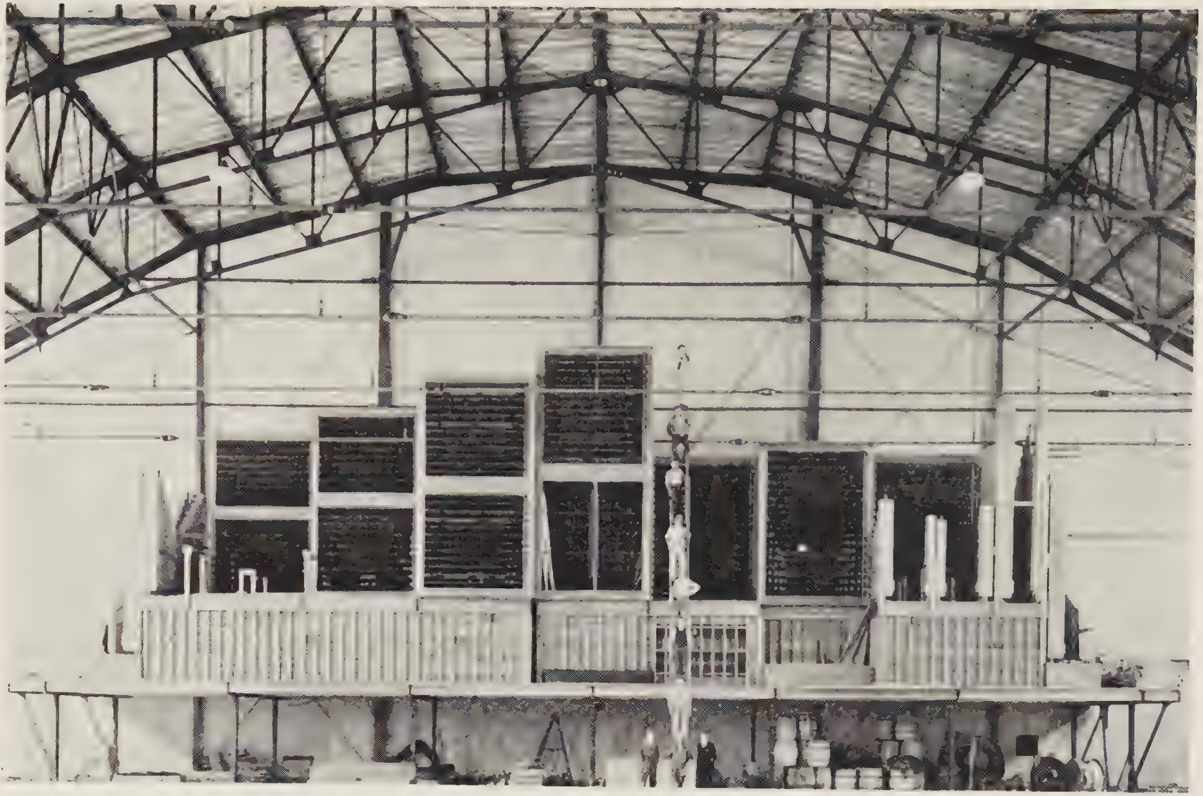


Plate XXIV.

The organ built by the Austin Organ Company for the Sesquicentennial Exposition at Philadelphia in 1926, now installed in the Irvine Auditorium, University of Pennsylvania. The blowing plant is shown at the lower right. The re-enforced construction of the Austin Air chest is shown. The greater portion of the pipes are behind the horizontal shutters in the seven expression chambers. The organ was spread out across the stage for nearly one hundred feet in its original location.

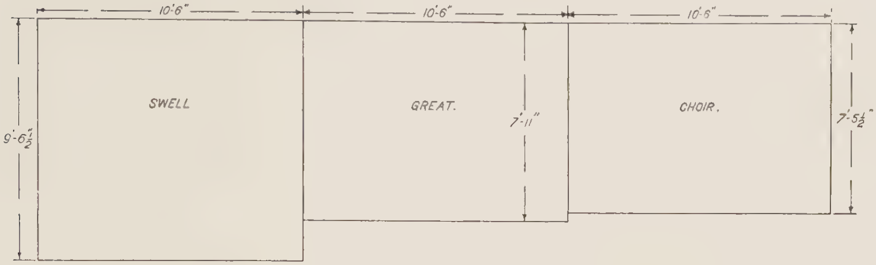
peratures there, than in a basement, particularly in the summer time. A good rule to follow is so to place an organ that its tone may be free, and directly accessible to the place where it is to be heard.

The tone of an organ can be made to go around corners and follow devious paths, but all such obstructions and interference with the direct egress of the sound creates considerable loss in volume. This can be partially compensated by higher pressures and excessively loud voicing. The results are never as satisfactory as when the tone can proceed more freely and with more normal speech of the pipes.

Another matter that should be considered by architects in regard to organ chambers is the material which is to form the walls of the chambers. Whether part of the organ is to be left without expression, or whether all the pipes in the chamber are to be enclosed behind shutters, is immaterial to the consideration that should be given to the walls themselves. Under ordinary conditions, walls made of hard patent plaster are quite successful in sound reflecting properties. Where a greater amount of reflection is desirable, Keene cement is sometimes used. In no event should rough or sand-finished plaster be used, as particles are apt to drop off into the pipes by vibration of the organ and such a surface is not so good a reflector of sound. Hard wood walls are sometimes desirable in a basement location, particularly as they will absorb part of the dampness.

The wall surfaces should preferably be as smooth and free from obstructions as possible. Some builders prefer to make the corners concave, thereby avoiding sharp angles. This does not appear to be of great importance, ordinarily. It is, however, very important that the openings shall be free to practically the top of the chamber in order that a very undesirable tone pocket shall not be created above the opening. This will cause an appreciable loss in the amount of sound which will issue from the chamber. Unlimited height above the pipes is not desirable but simply enough for adequate speaking room.

Mr. Leslie N. Leet, the Technical Director of the Organ Department of the Aeolian Company, has written an interesting monograph which appeared in various issues of "The American Architect," giving some particulars as to the organ sizes and space requirements for churches and auditoriums. Mr. Leet states, "The manual pipes of each organ division stand on a windchest in rows. The longer pipes, of certain stops composed of pipes of large diameter and needing a large quality of wind, do not stand with the balance of the stop, but are set on separate chests of small size. Separate chests for the large pipes relieve crowding on the manual chest and assist in obtaining a steady wind condition for the smaller pipes.



Space requirements of the manual pipes of an average sized three manual organ.

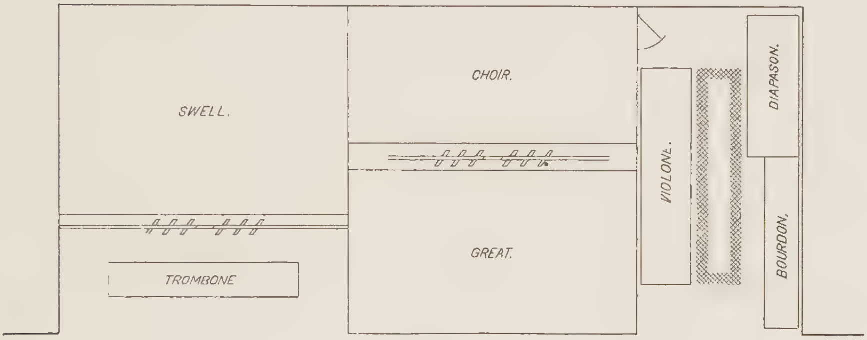


Figure 45.

Showing another possible layout of the same organ, with the pedal pipes disposed at the side and some of the pedal reeds in front of one of the manual divisions.

"A manual windchest, as constructed by practically every major builder in this country, is 8′ 6″ long. It varies in width as required by the number of stops that must be mounted on it. Allowing for the numerous conditions that must be included in one manual windchest, it would not be safe to allow less than 9″ per stop in determining this width. There are many stops that may need but 5″ to 6″ while others may require up to 11″, but a check over several representative organ layout has shown that the figure of 9″ per stop will produce safe results. The manual windchest, as stated above, is 8′ 6″ long and as wide as required for the number of stops to be included on that chest. In addition to the width of the chest, there should run parallel to it a walkboard for the tuner when servicing the organ. For practical reasons, this board should not be less than 15″ wide. On three sides of the chest one foot is required for space to hold the offset bass pipes which are not placed on the manual windchest chiefly due to their large size.

"A basis has now been established for estimating the space for each manual division of the organ. The length is fixed by the length of the chest plus the extra foot needed at each end, the width by the number of stops multiplied by 9″ plus 15″ for a walkboard and one foot for a bass chest. These figures hold good for a division up to about 12 stops over which it would be well to allow two feet on the three sides of the chests for basses and other large parts that may require extra room."

It now becomes necessary for the architect to know approximately how many manual stops will be required in the organ and how many divisions. This will vary, of course, with the money at the disposal of the church and it is almost imperative for the architect to have some general idea of what the church proposes to spend for an organ before he can provide an adequate amount of space. In general, the small sized church, seating from three to five hundred people, will purchase an organ costing from five to fifteen thousand dollars which will contain a minimum of five and probably a maximum of thirty stops.

Mr. Leet gives the following table, which architects may find to be of value, and will serve as a rough guide in any event. The size organ that can be purchased for a given amount will vary greatly in accordance with the builder chosen. The same sized organ may be purchased from one builder for five thousand dollars, for which the highest priced builder will require double this amount, so that money at the disposal of the church is not a guide to the size organ that they will be able to install, until it is known somewhat definitely what builder they are considering.

TABLE A**

	SIZE OF ORGAN (NUMBER OF STOPS)		
No. of Seats*	Minimum	Fair	No. of Manuals
100 or less	5	8 to 10	2
250	6	12 to 15	2
400	8	15 to 20	2–3
600	10	20 to 30	2–3
800	12	25 to 35	2–3–4
1000	15	35 to 40	2–3–4
1500	20	40 to 45	3–4
2000	30	50 to 75	3–4

*—For purposes of this table it is expected that the proportions of the building are normal for the number of seats.

**—It is admitted that few organists will agree that this table is of any value.

It becomes a matter of considerable importance, therefore, in order that difficulty will not occur later, that the architect have something fairly specific from the church with regard to the plans for the organ before he can with any great certainty provide suitable space.

The pedal pipes require additional room besides that provided for the manual pipes. The amount of necessary space is given in Mr. Leet's schedule B.

"To find which stops should be used, determine how many pedal stops the manual stops require on the basis of one to six or seven and then take the required number of pedal stops in order, starting from the top of this list.

SCHEDULE B

1. Bourdon	16′	44 Pipes
2. Open Diapason	16′	44 Pipes
3. Trombone	16′	44 Pipes
4. Violone	16′	44 Pipes
5. Diapason	32′	12 Pipes
6. Bombarde	32′	12 Pipes
7. Second Bourdon	16′	44 Pipes
8. Metal Diapason	16′	44 Pipes
9. Bourdon	32′	12 Pipes

(The stops containing 44 pipes are intended to be played at 16 and 8 foot pitch.)

The space required for these pipes with their chest work will be:

		Pipes	Length	Width	Height
1. Bourdon	16′	44	13′6″	3′6″	10′6″
2. Open Diapason	16′	44	12′0″	2′6″	19′0″
3. Trombone	16′	44	10′4″	1′4″	12′0″*
4. Violone	16′	44	10′4″	1′5″	19′4½″
5. Diapason	32′	12	18′9″	3′8″	34′9″
6. Bombarde	32′	12	10′3″	2′4″	23′0″*
7. Second Bourdon	16′	44	Same as No. 1 approximately.		
8. Metal Diapason	16′	44	8′9″	2′9″	21′0″
9. Bourdon	32′	12	15′3″	2′0″	18′0″

*—Average mitered length.

"As these very deep voices of the organ require space for 'speaking room,' at least the width given should be allowed in front of the stop throughout its full length. This speaking room should allow of unobstructed outlet to the tone openings for the organ. The detail of the speaking room and opportunity for the tones to escape is very important.

"The heights given are for the pipes, with the exception of the Trombone and Bombarde, unmitered. When height is at a premium and extra space in plan is available mitering the large pipes can be resorted to."

General plans will not fit all cases, but Figures 44 and 45 suggest possible schemes. In general, it may be stated that, if an architect can allow a space 10′ deep by 21′ high, he will have allowed the ideal proportions for a chamber and a size sufficient to accommodate an organ of average size for a church seating up to six hundred people. Two chambers 10′ square and 21′ high on either side of the chancel will be equally satisfactory. Chambers that are deeper than this should be avoided, ex-

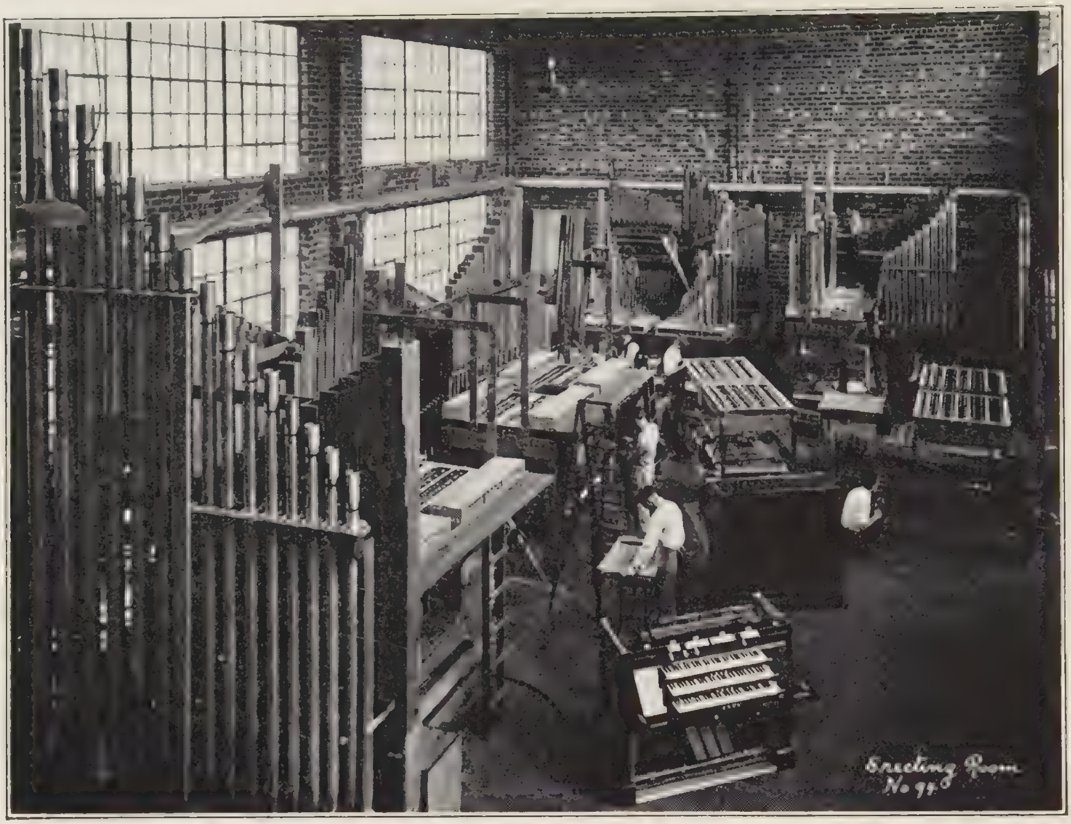


Plate XXV.

A section of the erecting room of Geo. Kilgen & Sons, St. Louis, Mo. Several windchests are shown before the top boards have been placed in position.

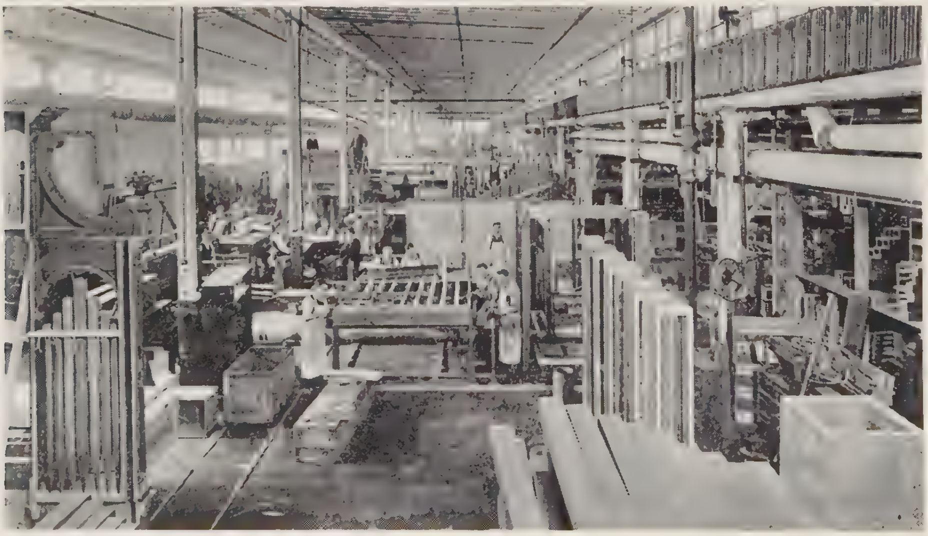


Plate XXVI.

A portion of the Welte-Tripp Organ factory at Sound Beach, Conn.

cept in very large organs and height less than 13′ should be avoided. The 21′ height suggested will permit of "double decking" the organ, that is placing the manual pipes on two levels. Large organs have been crowded and crammed into space of much less height than 13′. Even as low as 8′ and into undesirably deep recesses, but only at the expense of the effectiveness of the organ, and the great inconvenience of the organ builder. Large churches will require proportionately larger chambers and perhaps the minimum sized chamber that should ever be provided where a pipe organ is contemplated, even in small churches, would be one 10′ square by 13′ high or 1300 cubic feet. This would permit of the ready accommodation of an organ of some five sets of pipes which is about the smallest practical church organ. If the church cannot afford an organ as large as this, it is usually better off with a piano or harmonium. Such a size will provide ample speaking room and the opportunity for the builder to employ good sized scales without crowding. If much less room than the dimensions suggested is allowed, the organ may be squeezed at the expense of speaking room for the pipes, and usually requiring smaller scaled pipes as well.

The whole matter is one that will well repay the study of those contemplating the installation of an organ. The following axiom should be self-evident, but it is surprising how often it is lost sight of, that if it is worthwhile for the church to spend its money for an adequate organ, it is worthwhile for the church to provide adequate space for the organ and a location where it will be heard to the greatest advantage. This also includes the provision of sufficient tone openings.

In the case of residence organs where volume is not so essential, tone openings may be proportionately smaller than for church organs. An organ without sufficient tone openings will always sound subdued and bottled-up and somewhat distant, no matter if high pressures are employed or how loudly the pipes are voiced.

Considering the disposition of the various divisions of the organ in the chamber, organ builders are not agreed as to whether it is more desirable to place the pedal pipes in front of the manual divisions or at the side or behind them. This is a matter for the individual builder to determine and does not concern the architect of the church.

It has been my experience that it is usually desirable in the case of an organ which is entirely enclosed by expression shutters to place the Great Organ Diapasons immediately behind the shutters in the most highly advantageous position possible, and to place the pedal pipes at the side and back of the chamber. The tone of the pedal pipes can be forced if necessary with less injury than that of the manual pipes. Some of our builders make a practice of placing the pedal pipes in the most advantageous position with regard to the opening and this has the advantage of assuring a big pedal for the organ. If this is done without being at too great expense to the manual divisions, it may be worthwhile. I should prefer to take my chances with the former layout. These matters of actual layout of the organ, as has been indicated, are best left to the builder and his judgment.

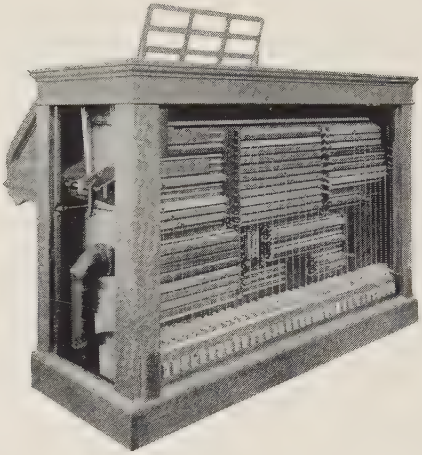


Figure 45-a.

A view showing the back portions of the standard console made by the Hall Organ Company. It should be observed that all the coupler switches and the action parts are readily accessible.

Plate XXVII.

A portion of the windchest room in M. P. Moller's factory. In the foreground are a number of windchest bars that contain the pitman stop action boxes, which are shown in detail elsewhere in this volume.

CHAPTER 15.

A HISTORY *of the* ORGAN ACTION

BEFORE proceeding with our account of the history of the development of organ actions and at the risk of being elementary to many, it may be wise to give a brief explanation of some of the technical terms that we shall use in this account.

As everybody knows, the tone of the organ comes from the pipes. It was the custom to place the pipes of the lower notes of the Diapasons in the front of the organ for many years. These pipes many people believed to be all that there were in the organ. The present day custom of placing the organ behind a screen or grills without any "show" pipes whatever does not give the interested observer an idea of what even the bass pipes look like unless he actually goes into the organ chambers.

Pipes are of various shapes and sizes and vary in length from 32 feet long, in large organs, up to pipes no greater in speaking length than 3/8 of an inch. They are usually arranged in double ranks or rows upon a box of wind with valves directly beneath the top of the air box or *windchest,* that permits air to enter the pipes when the keys are depressed, with certain modifications as will be explained hereafter. Each of these ranks consists of a complete series of pipes of similar tone quality and called a *stop* or *register.*

The word "Stop" in this connection refers actually to the rows of pipes and not to the stop knob at the console which operates the mechanism bringing the row of pipes into play. Considerable confusion arises in the minds of the uninformed on this point as they are inclined to look upon the number of stop knobs or stop keys at the console as indicating the number of actual rows of pipes the organ contains. All of the reliable and competent builders in the United States at the present time make it very clear in the specifications which they submit to the intending purchaser of an organ exactly the number of sets of pipes that the organ will contain and do not permit such confusion to arise between stops and stop knobs.

The average church organ built during the Nineteenth Century contained three or four windchests each with its quota of pipes and designated as follows: 1. the Great Organ, consisting of the bolder and loud speaking stops, such as Diapasons, whose bass pipes frequently were placed in the front of the organ as part of the case work. Back of this, and usually elevated above the level of the Great Organ, was 2. the Swell Organ, all of whose pipes were contained in a wooden box with Venetian shutters in front, the opening and closing of which modified the tone.

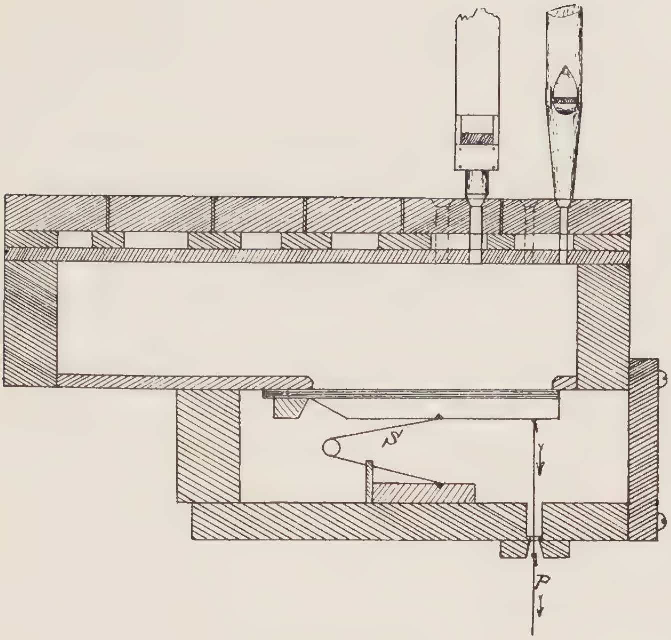


Figure 46.
Sectional view of the pallet and slider windchest.

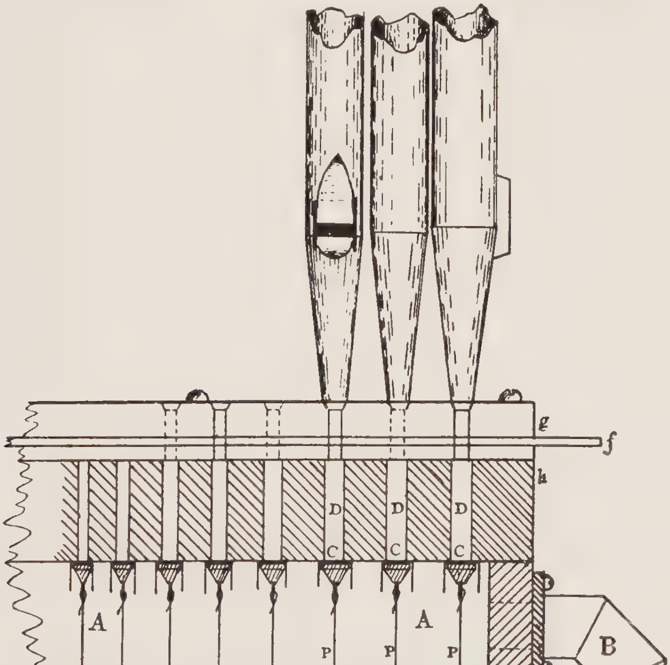


Figure 47.
Sectional front view of the same windchest.

Below the Swell Box was placed 3. the Choir Organ containing the soft speaking stops useful for accompaniment purposes and back of these divisions, or on either side, was 4. the Pedal Organ, containing the large pipes of the deeper pitches played by the pedal keyboard.

It was seldom that a church organ exceeded three manuals for reasons that will appear evident as we describe the action.

These various divisions of the organ make it possible for a much greater variety of effects where solo melodies may be played on one keyboard, accompanied on another, or an entire change of tone quality may be obtained by alternating from one keyboard to the other without a change of stops. Perhaps the origin of so dividing a church organ was the impossibility of supplying a large number of stops with wind from a single windchest. It will be seen from this that the average church organ is in reality made up of three or four small organs combined, under the control of one player.

The windchest is an oblong box supplied with air under pressure from the bellows. The box contains the valves called "pallets" which control the admission of wind to the pipes. We are now describing the typical windchest that was invariably used with the tracker action. Between the pallet and the foot of the pipe another valve is interposed called the "slider," which controls the access of the wind to the whole row of pipes or stops. The pallet is operated from the keyboard by the key action. Every key on the keyboard has a corresponding pallet in the windchest and every stop knob operates a slider which controls a set of pipes, so that both the stop knob must be drawn, and a pallet must be depressed, before any sound can be obtained from the pipes.

THE TRACKER ACTION WINDCHEST

Figure 47 is a front view, and Figure 46 a side view of the windchest. Wind is admitted by means of the wind trunk B into the interior of the windchest A. The pallets C, C, C, are held against the openings or channels leading from the windchest to the feet of the pipes, by springs underneath them. The spring S in our figure holds the pallet C against the opening into D. The pallet is drawn down by means of a wire, known as a pull-down, which passes through small holes in a brass plate affixed to the bottom of the windchest. This wire is connected with the keyboard by means of a series of mechanisms which we shall presently describe. The pallet is hinged at the back and guided in its downward motion by means of a guide pin. The top of each pallet is covered with felt and on top of this, soft leather to make it fit airtight against the grooves and to work quietly. When the pull-down wire is pulled down,

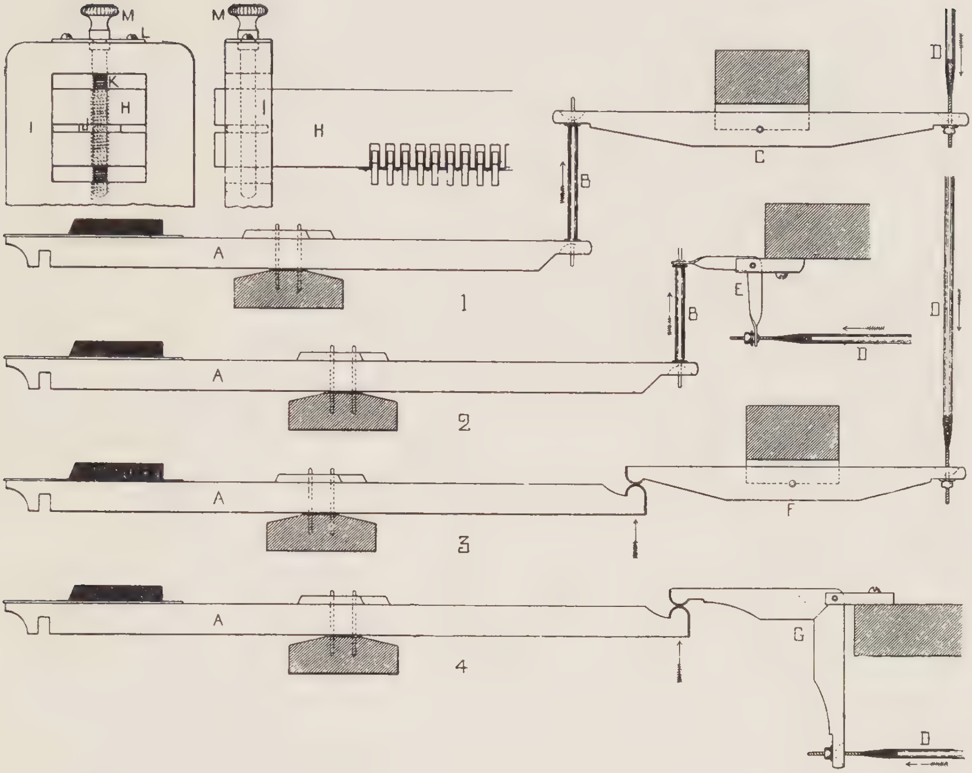


Figure 48.

Four ways of making the mechanical connection between the keys and the pallet valves in the tracker action. In drawing 1, the motion is transferred by the sticker, B, to the lever, C and thence to the tracker, D, which connects with the pallet in the windchest Drawings 2, 3 and 4 show variations. (From G. A. Audsley, "The Art of Organ Building.")

the pallet C is opened and air from the windchest A rushes through the channel D into the pipe above. However, the slider F which is a narrow strip of wood that is placed between the wood work G and H in such a manner that it may be moved backward and forward transversely across the chest may interfere with this. At the time the windchest is made, holes are bored through the top board or the board on which the pipes are placed, and the slider and the table part of the windchest, so that the holes in both the top board, slider, and table exactly correspond when the slider is in the open position. If, however, the slider has been moved a short distance, usually 3/4 or 7/8 of an inch to one side, the holes in the slider no longer correspond with the holes in the top board and table and no air may be admitted to the pipes, even though the pallet is open. When the holes in the slider exactly correspond with those below the pipes, the stop, the handle of which controls the position of the slider is said to be out, or drawn; when the holes do not correspond the stop is said to be in. Thus it is evident that when no stops are drawn no sound is produced, even though the windchest is full of air and the keys are depressed.

The mechanism which connects the back end of the key with the pull-down wire of the pallet is shown in Figure 48. In its simplest form, it consisted merely of a small dowel of wood called a "sticker," into which a small pin was driven at either end, that was fastened in a hole at the back end of the key, the top of which actuated the square, which in turn actuated the thin strip of wood called "tracker" from which the name tracker action is derived. The tracker had secured on one end of it a tapped wire (that is, threaded so a leather button could be screwed on), which connected with another square which in turn was the pull-down wire. Our illustration makes this clear. It was quite the principle of the old-fashioned bell pull that was mechanically operated, by means of wires and bell cranks. See Figure 48.

Occasionally in place of the two squares and trackers for each note, a lever was introduced between the back end of the key and the pull-down wire which transferred the motion with even greater simplicity. The difference in the scale at the back end of the keyboard and the wider chest scale from which the pull-down wires proceed, required either the trackers or levers to be arranged in a fan shape. Actions were still further complicated by reason of transferring a number of the bass pipes to the opposite end of the windchest, instead of arranging all the pipes in chromatic order from large to small. As this does not correspond with the way the keys progress regularly upward, the motion of the keys had to be transferred across the windchest by means of rollers, a series of which were called a roller board. All of these connections and joints (usually there were as many as six), were causes of friction between the key and the pallet. To overcome this resistance and friction a strong spring was required to return the pallet to its closed position. The pallets had to be larger in the bass end of the chest to supply the additional wind the larger pipes require, and as the area of the pallet was increased its resistance to opening was increased, by reason of the pressure of the wind against it. When the organ was a large one with many stops and the keyboards were coupled together, it required considerable exertion to bring out the full power of the instrument, as the resistance of the air against the pallets increases with more stops drawn. Sometimes the organist had to stand on the pedals, and throw the weight of his body on the keys to secure a big chord. All kinds of schemes were tried to overcome the resistance of the "touch," as the required pressure on the keys is called. The most successful of which was dividing the pallet into two parts which admitted a small quantity of wind to the groove or channel and thereby released the pressure before the pallet was fully opened. Naturally, with the tracker action, the weight of the touch was proportionately increased with each manual coupled to the one which was being played, and manual couplers were, therefore, introduced very sparingly. Most tracker organs having nothing but unison couplers between the Swell and Great and Choir and Great, though occasionally on two manual organs there were two couplers, coupling the Swell keyboard to the Great at both unison pitch and an octave higher.

Some of the work of our best American organ builders during this period, as exemplified by Hook and Hastings, and Johnson and Son, in particular, was quite remarkable for its extraordinarily careful workmanship, and the surprising thing is that large organs of this type could ever be made to work at all. Unless the workmanship and material had been of the best, it would have been quite impossible to play upon a large tracker organ.

In addition to perhaps the most serious disadvantage of the tracker organ, namely, the heaviness of the touch, especially with couplers added, the windchest also was never adequate to supply an even pressure of wind to the various rows of pipes. While there might be ample wind admitted through the channels for two or three stops, when all the stops were drawn there was a certain amount of "robbing" of the wind that caused the pipes to more or less flatten in pitch as not sufficient air could be admitted through the channel to properly blow all the pipes of a windchest. Leakage would also occur between the slider and top boards. To prevent adjacent pipes from sounding because of this leakage when only one pipe was intended to sound, grooves or channels were cut diagonally between the various pipe holes of the bottom of the top board and the top of the table of the chest. In damp weather the slider would swell and in dry weather there would be too much leakage.

With all of its difficulties, the tracker organ was a miracle of mechanical skill for its time and I even now get a thrill out of being in the interior of a large tracker organ such as may still be found in France, when it is being played, and seeing all the squares, trackers and levers moving. I probably feel about this as one of my friends said he did about a merry-go-round, that he knew of "no other instrument ever invented that had so much machinery devoted purely to pleasure." Tracker organs have practically not been built in this country for the past twenty years. They are nearly extinct, though occasionally a small one is still manufactured. An organ building friend of mine, while visiting a certain builder's factory recently, saw a small new tracker organ standing on the floor of the erecting room and remarked that "here was a tracker organ that hadn't been used yet." They are indeed a rarity now, though used tracker organs of all degrees of age are the chief source of income of some organ repair men, even today. The trackers have a way of breaking and many other derangements are possible. With the reliability that the electric organs have developed in recent years, it seems odd that it was ever thought that a tracker organ was more reliable than the modern electro-pneumatic organ.

In England, the windchest I have just described is still clung to by some of the builders, strangely enough, though all of their leading builders have adopted the electro-pneumatic action as standard for some time past.

THE BARKER LEVER

The next stage in the development of the organ action occurred when an organ builder, in the city of Bath, England, named Charles S. Barker, in the year 1832, invented a contrivance known as the pneumatic lever. This device uses the force of the organ wind itself to overcome the resistance of the pallets in the windchest to being pulled down. It consisted of the introduction of a small bellows about nine inches long and varying in width between one and one-half and three inches, that was inserted in the middle of the key action. The exertion of depressing the key was then reduced to the small amount of force required to operate the very small valve which in turn admitted wind into the little bellows. The bellows, upon being expanded by the wind pressure, pulled down the pallets in the windchest, thereby doing all the hard work.

Our Figure 49 shows the introduction of this device as improved by the eminent English organ builder, Mr. Henry Willis. "When either the finger or foot is pressed upon a key connected with K the outer end of the lever GG is pulled down which opens the pallet P. Compressed air in the box A then rushes through the groove BB into the bellows CC which rises and lifts with it all the action attached to L. As the top of the bellows CC rises, it lifts open the throttle lever D regulated by the wire M which prevents the ingress of any more compressed air through BB with the action of the key on the lever GG. When the bellows CC opens, the double acting waste valve E closes, and the tape F hangs loose. The compressed air, therefore, cannot escape. On the other hand, when the key raises the outer end of G the tape F becomes tightened and opens the waste valve permitting CC to drop into its

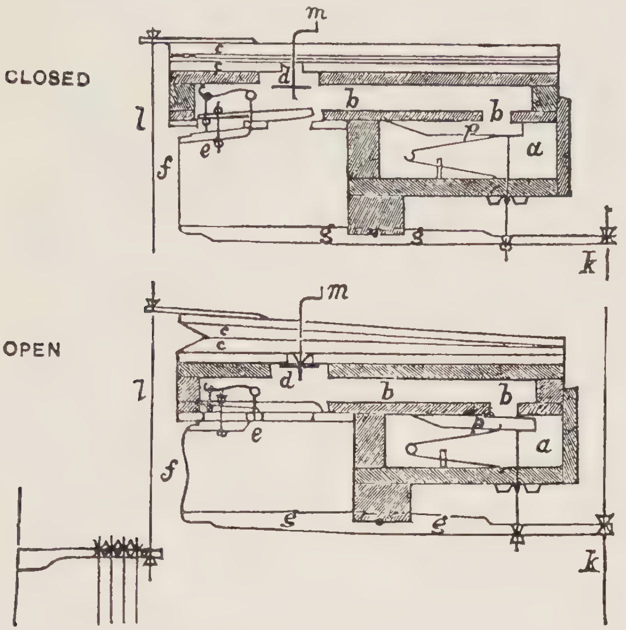


Figure 49.
One of the original forms of the Barker lever. Its operation is described in the text.

closed position, and no more compressed air flows through the pallet P."

This device enables the organ touch to be as light as that of the piano and eventually proved revolutionary in its influence by rendering possible extraordinary developments. When it was first invented and for many years thereafter, it was very much ignored and opposed by the English organ builders. Barker had to go to France and demonstrate the value of his device to Cavaille-Coll who, together with Willis, joined in its development and eventually all difficulties were overcome and the pneumatic action was brought into general favor. It was not used, however, except for large organs for a good many years. Modifications of this Barker lever were quite generally employed in large tracker organs built in this country up to within thirty years ago.

THE TUBULAR PNEUMATIC ACTION

Even when the Barker lever came to be adopted for use in large tracker organs, it was always a matter of great difficulty to run trackers for large distances as is the case where a keyboard was placed in a reverse position or at some distance from the organ itself. If the trackers had to be run down and under the floor and up to the other side, in the

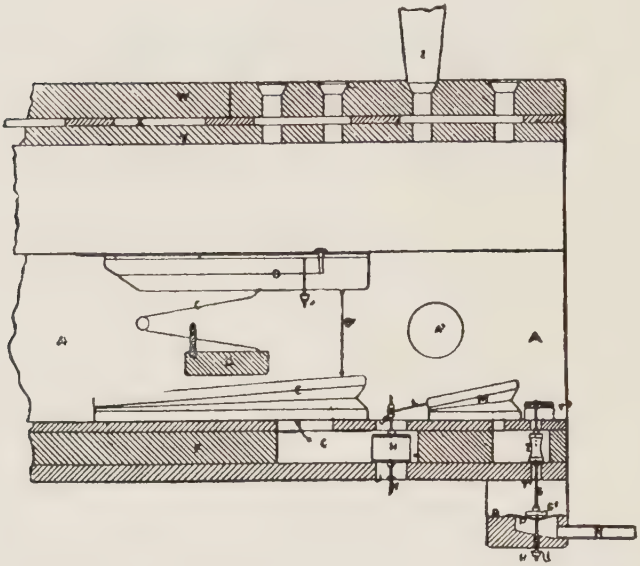


Figure 50.
Early form of the tubular pneumatic action.

case of a divided organ on either side of a chancel, it necessitated the motion of the keys to be transferred by direct mechanical means a large distance, with many attendant difficulties.

Dr. Gabriel Bedart of the University of Lille, France, apparently has brought to light the fact that the first tubular pneumatic action was constructed under Moitessier in France in 1835 and is designed upon the exhaust principle. Henry Willis built an organ for St. Pauls Cathedral, London, in 1872, which was divided in two sections, one on each side of the junction of the Choir with the dome, at an elevation of about thirty feet from the floor. The keyboards were placed inside one portion of the instrument into which he introduced the first tubular-pneumatic action in England.

In the tubular-pneumatic action an impulse of wind is made to travel through a series of lead tubes of moderate diameter between the end of the key and the Barker lever. The tubular-pneumatic action was reasonably satisfactory where the distances were not excessive between the keyboard and the organ, fifty feet being about the limit of usefulness of this type of action.

Sir John Stainer was the organist at St. Paul's at the time this action was introduced and describes it as a "triumph of mechanical skill," whereas the eminent English organist, Mr. W. T. Best, said that when this type of action was used for concert organs it was a "complete

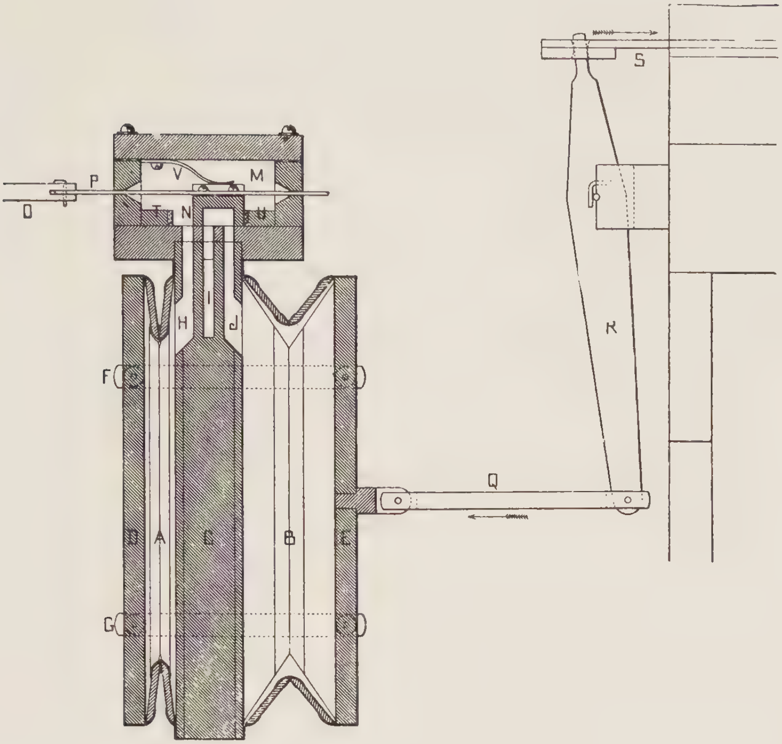


Figure 51.

The pneumatic stop action applied to the operation of a slider windchest. Compressed air is contained in chamber VM at all times. The stop rod, O, actuates the valve, N. In the position shown air will pass through the channel, H, into the pneumatic, A. At the same time the compressed air is pneumatic, B, will be exhausted through the channel, J, through the opening, I, in to the atmosphere. By this means the slider, S, can be moved to right or left, in accordance with the position of the valves. (Audsley, "The Art of Organ Building)

failure," "You cannot play a triplet on the Trumpet" and considered it "the most damnable invention ever placed inside an organ."

These actions were quite freely introduced into many important English organs especially by Henry Willis and Sons, and this firm brought them to a high degree of perfection. Some of the tubular-pneumatic actions I played, on very old organs of this famous make in London, when I was there a few years ago, were quite remarkable for their speed and efficiency. Figure 50 illustrates this type of action.

Tubular-pneumatic actions were never so much used in this country for some of our American builders jumped at one step from the tracker action, or tracker action with Barker lever, to some form of electro-pneumatic action. Most of the tubular-pneumatic organs which have come to my notice in this country were not models of reliability and had many drawbacks. The Kimball Company made a reasonably successful tubular-pneumatic organ, many examples of which are still extant. It is obvious that since pneumatic impulses travel relatively slow, a speed which does not exceed 1100 feet a second, that no tubular action could be entirely satisfactory when the distance between the keys and the organ is large, even though the action may be very perfect in design and workmanship. In the case of large organs where necessarily some of the tubes are short and some have to be very long, it is impossible to procure simultaneous speech from all the divisions of the instrument.

The tubular-pneumatic action has been abandoned by American builders the past twenty years in favor of the electro-pneumatic action, except in the case of very small organs where a simplified form of the tubular-pneumatic action may be employed and save the expense of generator and magnets. It is used in such cases merely for economy and not because the tubular-pneumatic action can compare with modern electro-pneumatic. Casavant still build a number of two manual tubular-pneumatic organs, though they were among the first builders to adopt electricity.

CHAPTER 16.

A HISTORY *of the* ORGAN CONSOLE

BEFORE entering upon a description of the individual types of organ action employed by the various American builders, some general remarks should be made relative to the organ console or keyboard. Previous to thirty years ago, it was not customary to have the console a separate or detached portion of the organ. In modern organs, however, it is almost invariably detached, and at a greater or lesser distance from the organ itself, in accordance with the circumstances. It should be placed where the organist can best hear his choir and organ. Small tubular-pneumatic and some electro-pneumatic organs are built even now with the console as a part of the organ proper. Occasionally tracker organs (or tracker organs with Barker lever) had a separate console, but these complicated the mechanism to such an extent that such a disposition of the console was rare, unless a very large or important instrument was built, or in other special cases.

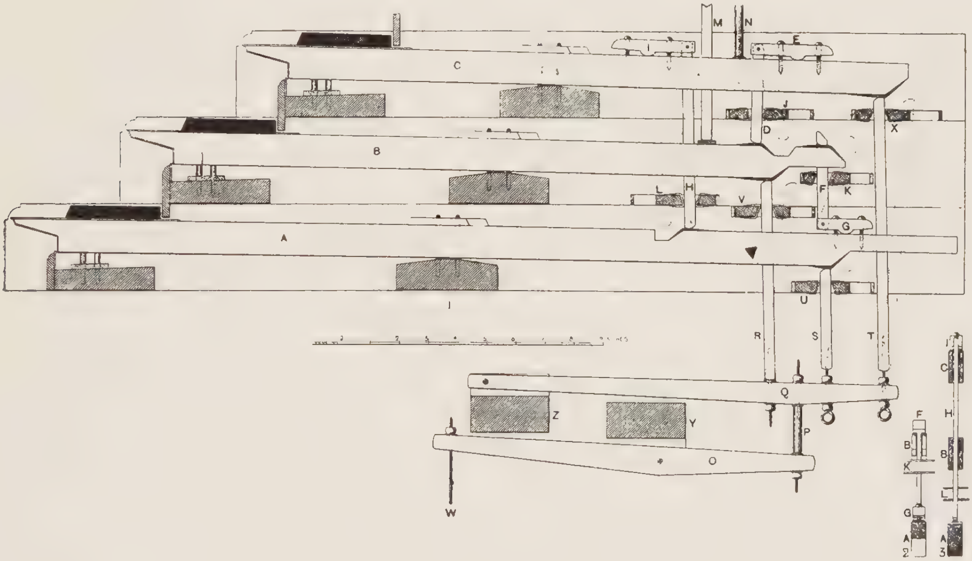


Figure 52.

View of the pedal couplers used in the tracker action. When a pedal key is depressed, it draws down the tracker, W, which moves the lever, O, in turn raising the lever, Q, which raises the Stickers, R, S, T, which raise the back ends of the manual keys. When the stickers are moved into the position shown in the dotted lines, they may be raised without affecting the manual keys. (Audsley, "The Art of Organ Building")

THE TRACKER ORGAN CONSOLE

In the typical tracker organ, the console consisted simply of the keyboards (both manuals and pedals), the draw stop knobs (with perhaps some combination pedals for moving a group of the draw stops at one time), and the couplers, for coupling the various keyboards together. There was also a Swell Pedal, inconveniently placed at the extreme right. All controls were ordinarily placed in a central position at the front of the organ case. The various motions of the keys and draw stops were transmitted directly to the pipe valves or sliders, as has been previously pointed out in our chapter on Organ Actions.

The only matter that should further be noted in regard to the tracker organ console (or, in reality, simply keyboards), is the means of coupling the various manuals together and the pedal keys to the manuals. This was accomplished as shown in Figure 52. It will be noted from the drawing that the pedal keys were coupled to the manuals by means of trackers and a system of levers. The back ends of the levers corresponding with the manual key scale, and the front ends corresponding with the pedal key scale which is, of course, much greater. These levers were, therefore, arranged in the form of a fan, the back ends of which had a series of oblong strips of wood approximately one-half inch by three-sixteenths in thickness that passed through a perforated strip of wood. The back ends of the manual keys were bevelled so that by drawing this perforated strip forward the complete set of "stickers," as these oblong strips of wood were called, would come immediately under the tails of the keys. When a pedal key was depressed, with the stickers in this position the back end of the corresponding manual key would be raised at the same time. When the coupler is in the "off" position, the perforated strip is moved away from the back ends of the keys so that the pedal keys on being depressed raise the sticker without affecting the manual keys. In order to put this arrangement on the tail ends of the upper keyboard, they had necessarily to project further back than the lower keyboard. This involved drilling a hole through the top keyboard for the stickers of the lower keyboard to pass through, in order to transmit the motion of the lower keyboard to the windchest mechanism.

The coupler system between the keyboards was simply a series of jacks attached to a strip of wood, each jack moving independently with the motion of the key, with sufficient clearance between the two keyboards so that the lower keys could be depressed without affecting the upper keys when the series of jacks was in the "off" position. A small inclined block of wood was attached near the back end of each key of

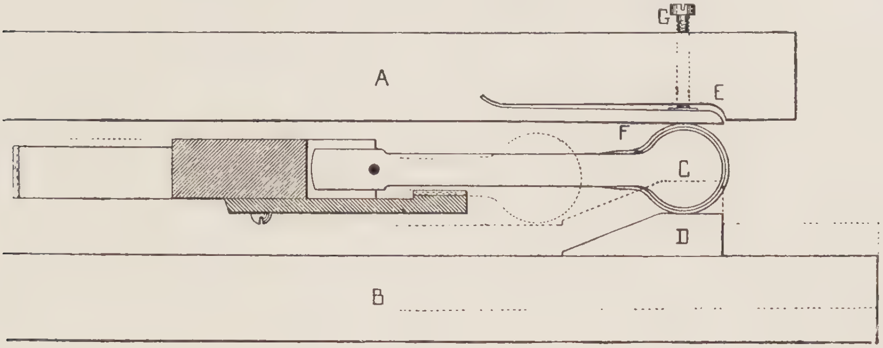


Figure 53.

The Swell to Great Coupler used in the tracker action. The coupler is shown in its On position. When moved in to the position shown by the dotted lines, it no longer acts on the Swell keys. (G. A. Audsley, "The Art of Organ Building.")

the lower manual covered with leather. The jacks could be brought up this incline by putting the manual coupler into the "on" position. Figure 53 illustrates this.

The distance between the back ends of the two keyboards with the jacks in this position was close enough to have the effect of joining the motion of the two keyboards. Upon depressing a key of the lower keyboard, it would immediately impart its motion to the upper key. In all these forms of tracker couplers, the keys themselves actually moved. When the pedal keys are coupled to a manual, the manual keys actually move down when the pedal keys are depressed. This was a guide to beginners in learning to play the organ as to what pedal notes were being played. The modern organ action provides no such assistance.

The stop knobs, as has been indicated, operated the sliders on the top of the windchest, through a series of squares and levers. By arranging blocks of wood on a series of the stop rods, back of the point where the knob passes through the stop jamb, and providing a roller or fan with arms attached to it that would engage these blocks, with a suitable motion from an iron pedal to move this roller, a series of stops could be brought on with one motion of the pedal. The exact stops to be brought "on" by a combination pedal had blocks secured to the stop rods that were to be moved. Combination pedals were frequently made double acting, with two sets of rollers so that by one motion, stops that were wanted were pulled out, and the ones not wanted would be pushed in. In nearly all cases the combination of stops so drawn or pushed in had to be fixed permanently. It was a very difficult matter to make any changes.

It was usual for organs to have two or three combination pedals for each manual. These were permanently adjusted to draw progressively a soft combination, a mezzo combination, and all the stops on that division. Combination pedals worked well when the stop knobs themselves worked moderately easy. When a series of sliders became damp, thereby causing them to work with considerable friction, a great amount of exertion was necessary to pull out or push in a group of such stops and generally entailed an enormous amount of clatter and noise when such motion was accomplished. It should be obvious that these pedals were a great convenience to the organist, especially where the organ was of considerable size. The utter impossibility of changing a large group of stops entirely by hand rapidly, is quite evident to any one who has tried it.

This comprises about all the mechanism that was in the console of the old tracker organ and it was quite enough, when all the parts had to be made by hand. The author made entirely with his own hands such a console mechanism when he was a boy starting high school. The result of this labor has given him a very wholesome respect for the tracker organ. It has also given him a very intimate knowledge of such mechanism that could not possibly have been obtained in any other way.

While I would not for a minute wish to return to the tracker organ for steady use, I always have a feeling of being perfectly at home on such an instrument that I played for so many years, and a feeling of intimate contact with the pipes themselves that one never experiences in playing an electric organ. Undoubtedly for the lay reader not versed in organ mechanism, the tracker action is much the simplest to understand, as all the motions are purely mechanical and can actually be observed. Whereas, in the pneumatic and electric organs, a good part of the motion is accomplished by invisible means such as electricity and wind pressure.

Until I examined closely these latter types of action, there was always a certain amount of mystery about them. Of course, I knew in a general way what was accomplished by these improved types of action, as practically every person knows who is interested in the organ in general. But specifically and exactly, what happens when a key is depressed in an electric organ, and why all the train of mechanism that is set in operation by such a motion of the key takes place, was not entirely clear. I hope to be able to make it so to any reader who carefully studies this book, though it is a highly technical subject and somewhat difficult to explain without actually seeing the parts themselves. By means of the large series of drawings and photographs that are presented, these matters may be made much more clear than any words can possibly make them.

The next stage in the development of the console occurred with the introduction of the Barker lever to the action. The manual couplers were attached to the lever mechanism, in this case. The weight of the touch was not increased when the couplers were drawn. Figure 49 shows this clearly. When the Barker lever was first introduced, the stop action remained tracker or directly mechanical.

THE TUBULAR-PNEUMATIC CONSOLE

With the introduction of tubular-pneumatic organs, the stop action became a modified form of the Barker lever, designed for the requirements of moving the sliders. This was accomplished by means of a pair of good sized pneumatics one of which, upon being inflated, would draw the slider out. The other would push the slider in. These pneumatics had necessarily to be made powerful, to overcome the resistance that would sometimes exist to moving the slider. The operation of the sliders from the keyboard was now made extremely easy. When a stop knob was drawn it merely opened the valve admitting air into the large stop action pneumatic. Figure 51 shows this. The hard work was done by the pneumatics.

At this stage of development a great improvement in combination action was possible, because the combination mechanism did not need necessarily to be operated by pedals. Formerly with the great resistance of a series of stops or sliders to be overcome, it could only be done by means of foot levers. When the stop action was made pneumatic the action became so light that a thumb piston or small button introduced between the manual keys could be made to accomplish the result equally well, and much more conveniently.

Combination pedals are generally believed to have been invented by J. C. Bishop in 1809. Henry Willis introduced into his organs thumb pistons about the year 1851, so that both these systems of controlling stops are in reality quite old. The coupler system of a tubular-pneumatic organ is shown in our illustration, Figure 54. Another device came into use with the introduction of pneumatic stop action, the register Crescendo Pedal. This pedal makes it possible to gradually cause all of the stops to sound, or by reversing the motion of the pedal to gradually silence them. This is done without moving the stop controls on the console, nor upsetting any combination of stops that may be drawn. It is a convenience for certain effects, and has a limited legitimate usefulness. It is also the first and last refuge of the incompetent player. To "pump" a register Crescendo Pedal instead of drawing stops by pistons or by hand, is so inartistic and so inexcusable, that the eminent organist, Mr. Edwin H. Lemare sees to it that this pedal is permanently disconnected from any organ he is to play regularly. I have

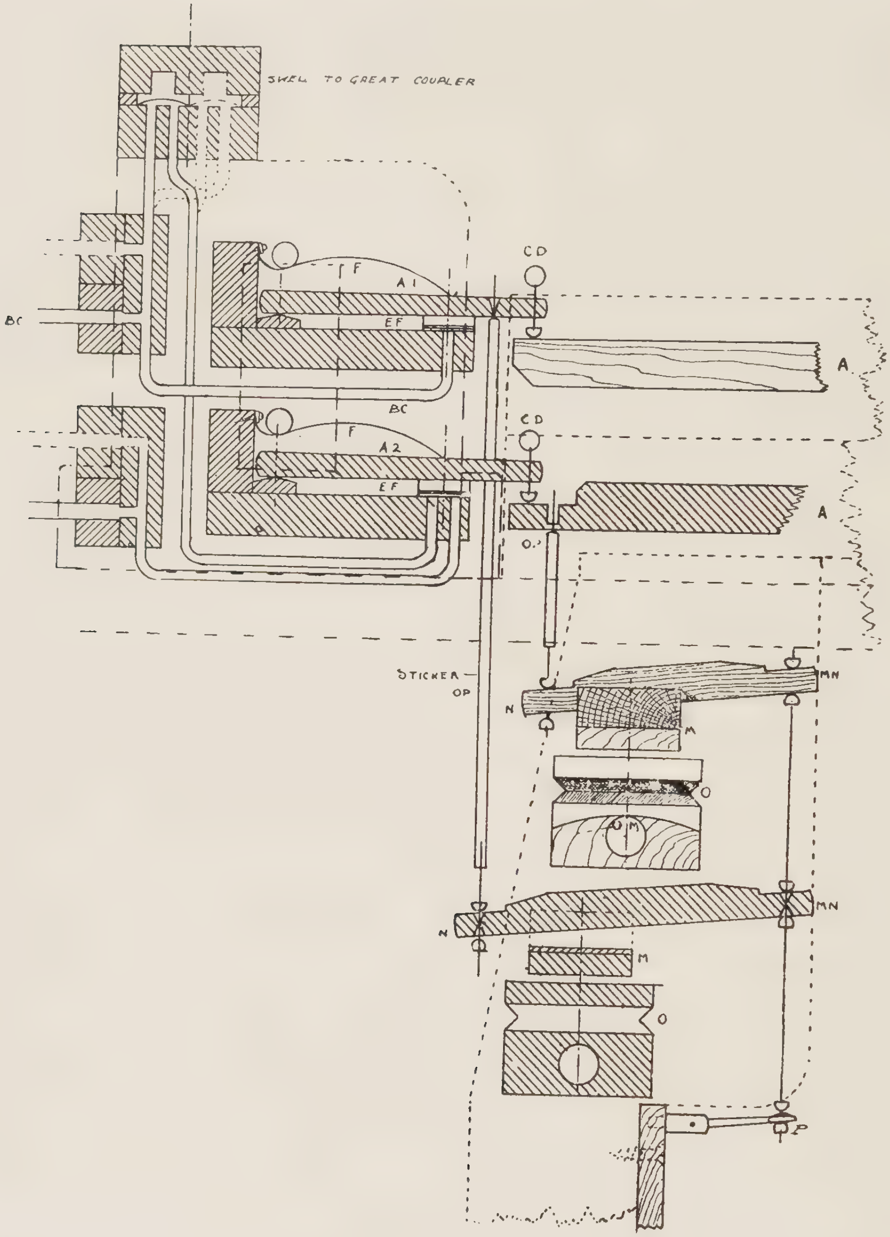


Figure 54.
Tubular pneumatic couplers. (From W. & T. Lewis, "Modern Organ Building.")

always contended, however, that the best the builder can do is to build a console with all conveniences. If some of them, such as Master Swell Pedals and Crescendo Pedals, Octave Couplers on the Great Organ, Tremulants and other devices are liable to abuse by the incompetent, it is unfortunate. If there are legitimate musical uses for these things, they should be furnished. An organ can scarcely be made fool-proof anyway. Nearly everything that an organ contains can be wrongly employed, and overdone.

Register Crescendos have been built with selective controls permitting of a Crescendo on Flutes, Strings, Diapasons or Reeds, or any combination of these qualities. This is a refinement that may be worth while in a large organ. I question its value.

Another pedal that is frequently duplicated by a piston (in each case both should be reversible), is the so-called "sforzando" or full organ pedal. One motion of the pedal or piston causes all stops and couplers in the organ that will produce a good full organ tone to immediately be brought on, without moving the registers. A second motion of the pedal or piston will re-establish the condition of pipes sounding to the registers as before. Sometimes two or more of these pedals are supplied, one drawing a mezzo organ and the other Tutti. Lights or other warning signals are usually provided to show when either the register crescendo or full organ pedals are in use, so that the organist will not think he is going to play softly with the stops he has drawn, and find that he is crashing down on the full organ unexpectedly.

The construction of these mechanicals is given in our chapter on Types of Organ Consoles.

THE ELECTRO-PNEUMATIC CONSOLE

Coming now to the consideration of the modern electro-pneumatic console, we discover that there are two general types in use. One contains all the coupler mechanism and combination action within the console itself. The other may contain the coupler mechanism but have the combination mechanism remote from the console, in which case the console can be made much smaller in size. Modern improvements have made it possible to provide a large number of combination pistons and have their mechanism placed within the console without making the latter too cumbersome. All modern combination actions visibly affect the stop knobs, or stop keys themselves.

The controversy that raged a number of years past in both "The Diapason" and the "American Organist" as to whether this should be so or not has now apparently entirely died out and no one at present seems to be advocating that combination pistons should not visibly affect the stop controls in the console. During the development of the modern electro-pneumatic console, however, it was discovered that by means of a recorder board which enabled the organist to set whatever combinations he desired, the stops inside the organ could be moved, without visibly affecting the mechanism at the console, thereby greatly simplifying the console itself, so far as the combination action was concerned. There are perhaps yet one or two builders who advocate this system for the general pistons. It seems a step in the wrong direction.*

A console that was used by the Hutchings-Votey Organ Company was probably the smallest and lightest organ console ever built, the sides of which could be folded up. The combination pistons did not affect the stop knobs visibly, but changed the stops themselves, within the organ. As this mechanism is now practically obsolete, except for the few organs around the country that were made with this system, it seems scarcely worth while to describe it in detail. It was simply one of the phases of development through which the electric console passed. It was an extremely ingenious console, and the only one that was truly portable, and easily movable. Some of our larger movable consoles could be better moved with a five ton truck.

In connection with adjustable combination action development, the name of Hilborne L. Roosevelt, the eminent organ builder of New York, should be mentioned as the first to introduce the adjustable combination action, along with Casavant. To him, also, is attributed the invention of the windchest with individual valves for each pipe, or the chest known as the "Roosevelt windchest," which type is still in use to this day. We have remarked elsewhere that he was a pioneer in electro-pneumatic organs in this country.

I believe it is unwise in a work of this kind to enter the controversy that exists at the present time, for or against stop keys and stop knobs in a console. Apparently the first stop control suggestive of stop keys was in use in Avignon Cathedral as early as 1804. Mr. William Horatio Clark of Reading, Mass., applied for a patent covering a certain type of stop key in 1877.

The present form of stop key in general use in consoles is generally credited, however, to Hope-Jones. The Austin Organ Company and others have greatly improved this form.

The Skinner Organ Company have persistently maintained the superiority of the stop knob console and consistently built this type. Whereas, the Austin Organ Company have advocated the stop key console and usually built this latter type. Many other builders adopting the Austin idea will build both kinds of console. Having played both kinds for many years past, I am less than ever inclined to dogmatize upon their relative merits. I can be happy and satisfied and comfortable with either type. The principal thing about a console, as Mr. Farnam once remarked, is, "does it work?"

---

*When the controversy was at its height as to whether combination actions should actually move the stop knobs themselves or work "blind," Mr. Skinner, who entertained strong opinions in this matter, is credited with the remark "that he knew some 'ivory knobs' in the organ business that couldn't be moved with any kind of a combination action."

In general, I believe the stop knob console presents a more handsome appearance and is the more traditional form. Because of the disposition of the stops at both sides as well as over the top of the keys, the combination action is rendered more complicated than when stop keys are used. This causes the stop knob type to be rather more expensive to build than the other. These matters are largely ones of preference and individual taste and as either type of console has now been brought to a very high degree of efficiency by nearly all of our American builders, with every convenience provided for the assistance of the organist, there is in reality little to choose between them.

STANDARDIZATION OF MEASUREMENTS

A matter that is of considerable importance to organists, however, is the proper dimensions and distances between the manuals and pedals. This has never been standardized as it should be in America. I have come to the conclusion that there will never, for many years to come, be any standard system of stop control, nor any standard system of what the individual manual combination pistons will affect. It should be observed that combinations are of two classes—the Universal, or general pistons affecting all stops and couplers and other mechanicals of the entire organ. The individual manual pistons and pedal toe pistons usually affect only the stops of their division. Two years ago a discussion of standards in the "American Organist," relative to combination actions, was engendered. Whether pedal stops should be affected by manual pistons or whether the couplers should be affected, and, if so, how and why, were the principal questions at issue. It is astounding, the different opinions that were expressed by many eminent people about this matter. I have my own preferences in the matter, while other organists prefer something quite different. I do not believe that any substantial purpose would be served by getting into this controversy. The Kimball Company solve this problem by providing on and off switches, the same as several other builders, for causing the pedal stops to be affected or not, by the manual pistons. In addition, on their larger organs

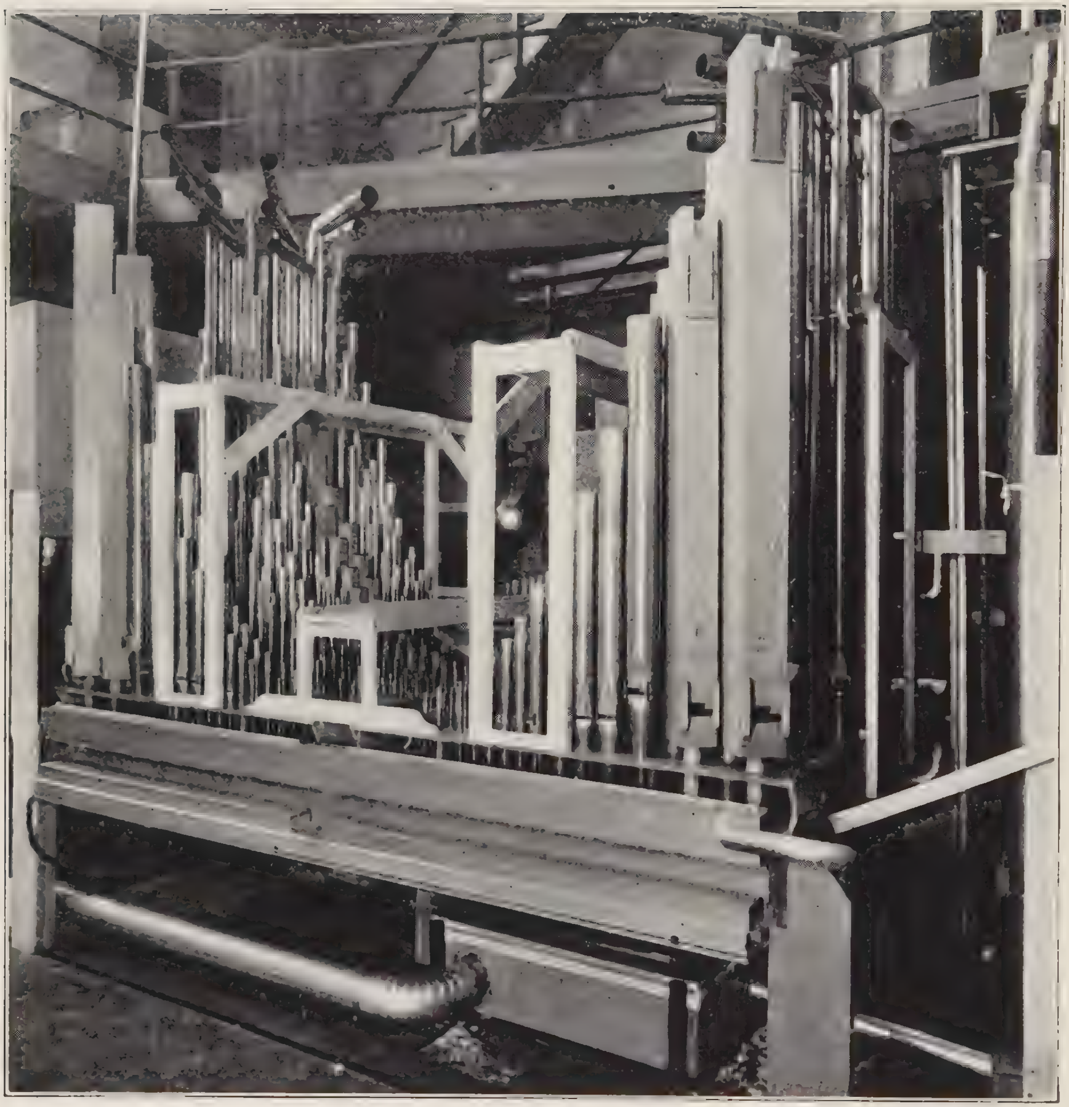


Plate XXVIII

A small two manual organ set up in the erecting room of the Moller factory. This will be placed in a chamber, so that no swell boxes are required.

this company provide another set of on or off switches or cut-outs, whose purpose is to make it optional with the player as to whether manual or pedal couplers shall be affected by manual and pedal pistons. One switch cuts out all couplers, while the other cuts out only the inter-manual couplers. The General or Universal pistons affect all the couplers and stops of the entire organ, as is usually the case.

Certain measurements, however, should be recognized as standard, such as distances between manual keys, and the distance of the pedal keyboard from the manuals. Keyboards should be two and one-half inches above or below each other. A distance of four inches from the front edge of one manual to a perpendicular line touching the front edge of the one above or below is tending to become standard. In a three or four manual organ, it is desirable that the height from the top edge of the center pedal key to the top edge of the Great Organ keys, shall be two feet eight inches (which brings the Choir manual 29½ inches from this point). Also, the distance from the front edge of the center black note of the pedals should be five inches back of the front edge of the great keyboard. It is important that the pedal keys should be placed sufficiently forward under the manuals, otherwise the organist has a tendency to pitch forward when playing on the upper keyboard on a four manual organ, and his pedals must be played in an unnatural position. The modern pedal keyboard of 32 notes is properly placed in a central position with regard to the manuals, instead of C under C as was common with shorter compass pedal boards. It has been well stated that "the convenience of the organist should be made the first consideration of the organ builder regardless of fads, hobbies or economics."

It has always seemed to me that at least the keyboards themselves might be standardized. This has been very largely done in the matter of manual keys, in regard to distances between centers of the keys being uniform. It is not the case with the pedal keys.

As far back as 1855 Henry Willis introduced in the organ in St. George's Hall, Liverpool, the radiating and concave pedal board slightly modified, that has now become standard in the United States. Seventy-five years ought to be a long enough period of time for the slowest of the organ builders to have gathered the necessary data on these dimensions and enabled them to reproduce the standard Willis pedal board. It does not appear to be so. Only recently I played a recital upon a new organ of a lesser known builder with what purported to be a standard concave and radiating pedal keyboard, whose measurements were so out of scale as to make it an extremely difficult matter to avoid playing many wrong notes (at least more than my usual percentage). It would require several days' practicing to become familiar and perfectly sure on this pedal keyboard, by which time the rather definite feeling of security which an organist may feel in playing on a standard pedal board would take several days more to reacquire. Such matters as this appear to me inexcusable and preposterous. Fortunately, all of our leading builders have at least agreed on a scale for the pedal board that is nearly enough alike as to cause no confusion in going from one of their organs to another.

As an example of the slowness with which improvements in organ construction are adopted, the matter of the radiating concave keyboard perhaps furnishes one of the best. It was fifty years after Henry Willis first introduced this pedal keyboard to organists and organ builders, in a very important organ where it would undoubtedly cause widespread attention, before this type of board was adopted to any extent in either England or America. Only as recently as twenty years ago, it was discovered, by means of a questionnaire sent to one hundred of the leading organists in this country inquiring which type of pedal board they preferred, that the vast majority still perferred the old-fashioned, inconvenient and thoroughly unscientific flat pedal board. Why? Because they were used to it and did not wish to trouble themselves to learn anything new. As far as the organ builder was concerned, he could not be blamed for continuing to furnish the flat pedal board which was obviously cheaper to construct, particularly as that was what the organist thought he wanted.

Happily, this matter is now finally closed and not even the most obscure organ builder in this country would consider building an organ without a radiating, concave pedal board of some sort, though some of them have apparently not taken the trouble to learn the correct measurements. Audsley's "Art of Organ Building" gives all particulars, with extreme accuracy.

The compass of the manuals has been fixed at 61 notes from CC-C4. In older organs, the range was seldom higher than A3 or 58 notes. Some large English organs extended downwards to GGG. These have now been rebuilt to the modern compass. A Canadian firm is advocating a compass of six octaves, from GGG to G4. There is certainly something to be said in favor of extending the pedal compass downward to perhaps AAAA, or GGGG as on the piano keyboard. It is very valuable to have the BBBB, AAAA♯ and AAAA available on the pedal, especially where there is no 32′ pedal stop. Mr. Lynnwood Farnam has long recognized the unsatisfactory effect of the pedal, especially in compositions written in the key of G, A, B flat or B, where no bass sufficiently deep is available. He has overcome this defect, without changing the compass of the pedal board, by installing the GGGG, AAAA, AAAA♯ and BBBB pipes of the Trombone on the organ he plays at the

Church of the Holy Communion in New York. These pipes are playable by special stop control, consisting of both stop knobs and reversible pedal (the latter Mr. Farnam considers of great importance for all 32′ stops), and provide tone in the 32′ octave, in the region where it is most valuable and effective. The cost of four of the smallest pipes is a small fraction of the cost of the entire 32′ octave. Whether they are installed (as in this case) as partial 32′ stops, or whether the pedal keyboard is actually extended to this compass is perhaps not so important as to have such pipes available. They are surely most useful, and make the rendition of music in the keys referred to even more effective than other keys, from the standpoint of a deep pedal. Here is something for organ builders and organists to consider.

Some organists are confused by reading specifications of organs that call for 73 pipes for each stop on the various manuals, while there are only 61 keys. When the manual keys are coupled an octave higher, if the stops have only 61 pipes, the octave coupler has no more pipes to act on for the top octave of the keyboard, and has therefore no effect. An additional octave of 12 pipes is usually provided so that the octave coupler may be effective throughout the entire upward compass of the manual keyboards. It is customary with some builders to provide no octave couplers on the great organ and therefore only 61 pipes are necessary for each stop on this division. To be perfectly logical an additional octave of pipes should be available at the lower end of the keyboard when the sub-octave coupler is used, otherwise this coupler has no pipes on which to act below tenor C. However, the top octaves of all the stops on a division will probably not cost as much as one bottom octave. To have any stop acted on in its entirety by both the sub and super octave couplers requires 85 pipes. Such construction is rare. The lower pipes are nearly always available on the pedal and to extend 8′ manual stops would only serve to make the organ sound muddy if chords were played in these lower regions. This is true unless we agree with Mr. Seibert Losh, who contends that a seven octave manual compass is most desirable. Let Mr. Losh speak for himself.

> . . . In a larger sense, any organ with five-octave manuals is a tracker organ. In a tracker organ large bass notes could not have their valves opened by finger power—foot power was required so the bass notes were exclusively controlled by pedal keys. So long as we cling to the limitations of the tracker organ we are still building tracker organs, actuated by electricity though they be.
>
> The introduction of seven-octave-manual organs provokes an amazing opposition from some quarters. Yet here is no alteration in the existing character or technic of the instrument—merely an extension horizontally of its tonal range. One plays the pedals as usual if that is desirable and convenient. Manual bass and treble is also available when and if desired.
>
> It is a reasonable assertion that the general avoidance of organ recitals by musicans, amateur and professional alike, is

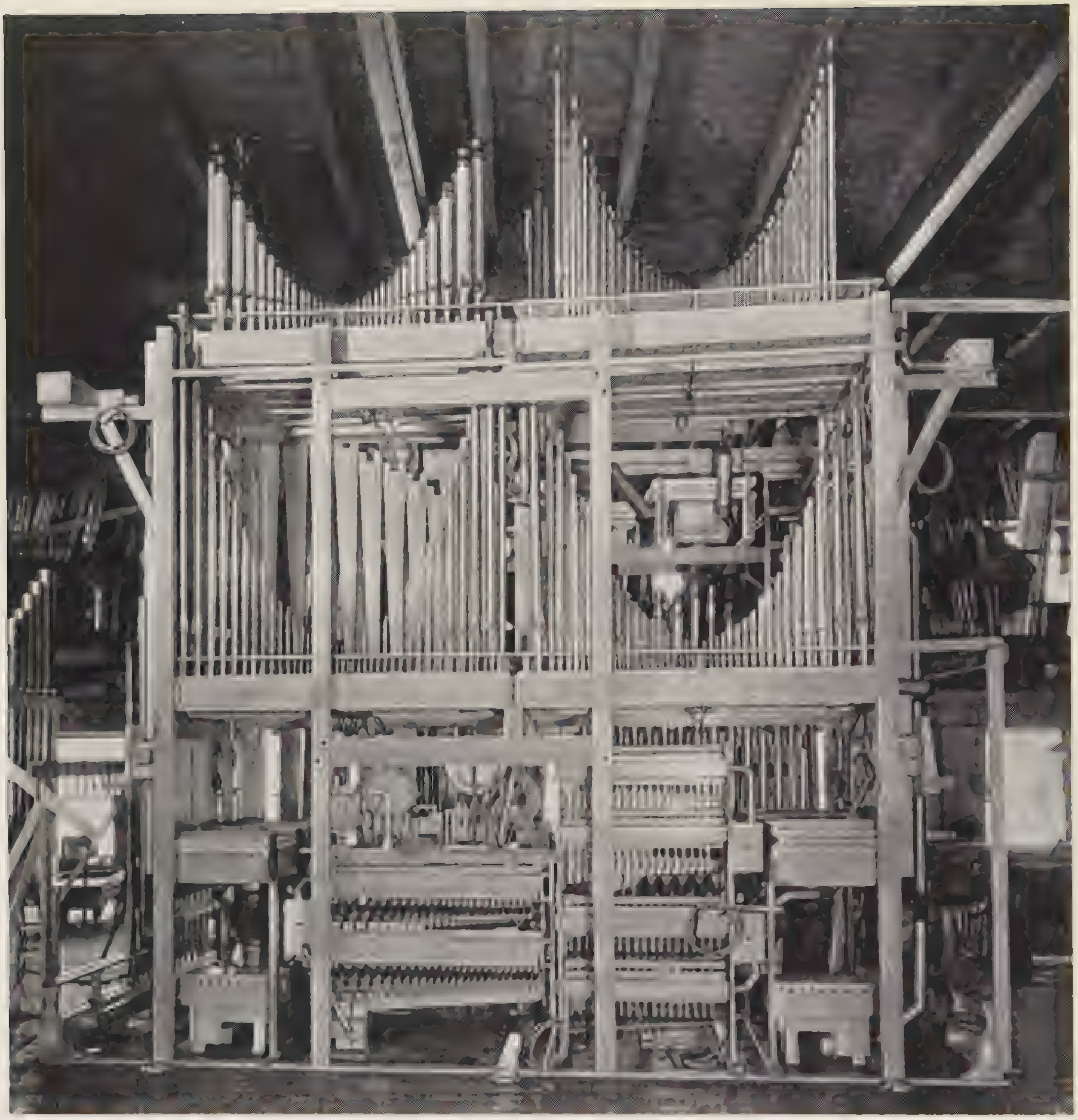


Plate XXIX.

A section of the Atlantic City Ball Room Organ. W. W. Kimball Company, Builders. The percussions are shown at the bottom and include a wooden marimba, a vibra-harp, snare drums, Chinese block, Bass drum, etc.

due in a large measure to the safe bet that the performer will exhibit his virtuosity in a composition at least partly pedal solo. Of all the pathetic sights under the sun, the funniest is to see an organist grasp the sides of the bench or console and trippingly render Bach and Franck—"trip" is right and "render" also. No man, living or dead, can play thus, to sound like music. No feeling, no phrasing, wrong keys, missed notes, awkwardness, bad taste, unintelligent, absurd!! Who can play foot scales or passages with a fraction of the speed, character, finish, and expression possible to the fingers? Why must the organ have a drone bass as the bagpipe? Why, also, may not the organ sparkle on occasion in the high trebles?

The major objection to transcriptions for the organ lies in the necessary distortion to accommodate the music to the limited manual compass of the five-octave organ, which really has a complete scale of but four octaves except in the key of C. What an anomaly! Nine octaves of tone in the organ and four octaves of it available manually!!

This preposterous condition forces the transcription to a remote key from the original, into abbreviation and distortion of scale and arpeggio, until the effect of the original composition is largely lost.

It is just as reasonable to object to the enlargement of the organ vertically, by additional stops, as to object to its enlargement horizontally by additional manual compass. How the released old prisoner misses and mourns his bars and fetters!

Perhaps the major difficulty of registration is to have ever available a suitable bass. Great to Pedal coupler is the most used stop on the average organ. Seven-octave design relieves this difficulty completely, for one manual and full organ at least. Any stop drawn on the seven-octave manual has its full bass available to the fingers. A Melody Touch may give you the Bass Note without reaching for it if desired. Sostenuto is practical in any part of the organ scale—more horror!

Some artists find great color effects in opening one crescendo chamber and closing another simultaneously. On a seven-octave organ this may be done without sacrificing the bass.

Many fine effects in the orchestra have two independent bass parts. This is possible and very effective in a seven-octave organ.

An elaborate melody of slow notes may be played with both feet on the upper keys of the pedal board with an effective bass played manually.

On any organ the performer has a melody and accompaniment standing choice equal to the number of manuals, but only on a seven-octave organ has he any standing choice of bass.

Organs that have been built with the seven octave manual nearly always have an augmented pedal so that the 16′ octaves of the manual stops are also available on the pedal. Perhaps it would be more correct to say that the pedal stops were available on the manuals. It will doubtless be many years, if ever, before the compass of the organ is generally extended to the limits Mr. Losh suggests, yet it is worth while to observe the ideas of one who does not believe in doing things as they have always been done. Although the seven octave compass for the manuals did not originate with Mr. Losh he has made more practical application of it than any other builder.

For the sake of completeness mention should also be made of a few of the many gadgets, touches, and attachments that have at one time or another been placed on organ consoles.

Mr. T. Scott Buhrman, the editor of the "American Organist," has for some years past kept for his own amusement a record of such alleged conveniences and attachments. A careful analysis of this list reveals the fact that most of the devices there enumerated are either not new, or are impractical, or both. To multiply "Trick" devices is a favorite practice of builders whose standard mechanism is deficient. The majority of organists, and among them the experienced recitalists, despise a console loaded with special devices. Mr. Palmer Christian once remarked of such a console, "It looks like the control board in a power house."

When the console is provided with an adequate number of manual pedals and general pistons, the organ can be best controlled without the use of other devices, which only serve to complicate matters.

One or two special devices, however, should possibly be mentioned. First:—Double Touch or Second Touch: Pressing the manual or pedal key much harder than usual forces it beyond the first point of resistance and carries it on down to a second and lower point, called Second Touch. This lower and second point has its own set of contacts which operate precisely in the manner of an entirely new manual division. A special group of stops are selected for playing from this Second Touch, usually the heavier voices in the organ, and some of the couplers.

Second:—Melody Octave Coupler: A device, controlled by a stop-knob or stop-tongue, which when in operation automatically duplicates the top or treble note at the moment being played, and adds it an octave higher to the actual notes played by the hands. It is instantaneous in operation and arpeggios will result from it if the chords should be carelessly struck in arpeggio fashion.

Third:—Melody Touch: A device used by C. Seibert Losh in a manner similar to Second Touch divisions of an organ, whereby a selected list of the normal stops of the organ are duplicated in a special set of stop-tongues which, when drawn, add themselves to the treble or melody notes only. In Second Touch, these supplementary stops come on only when any of the keys are pressed down harder to a lower point, whereas in Melody Touch no extra pressure is needed; the Second Touch and Melody Touch devices are similar in that both require the presence of certain selected additional stop-tongues to control the registers selected for Second Touch or Melody Touch use. On the other hand the Melody Octave Coupler does not require a supplementary group of stop-tongues, for it simply duplicates at the octave the melody notes of such registers as are at the moment being played.

Double or second touch was very popular with many theater organists. It enabled them to bring out a melody, not necessarily the top note played, against a suitable accompaniment on one manual, with one hand, allowing the other hand to be used for a counter-melody, or percussions. To utilize these facilities requires a somewhat easily acquired technique in playing. This has seemed to work against any form of double touch being generally accepted, though the idea has been employed in theater organs for many years. For a time it appeared to be receiving larger acceptance by church and concert organists, than now seems to be the case.

In general, it is fair to say that a console is most satisfactory when it enables an organist to do the things he wants to do with the greatest speed and convenience. It will be able to provide these facilities when it has a liberal supply of adjustable combination Pistons (in some cases duplicated by Pedals that visibly move the Registers; conveniently placed Expression Pedals; Crescendo Pedal (properly adjusted); Full Organ Pedal; and some Pedal Coupler Reversibles, conveniently near their respective Manual Pistons. This is really all that is necessary or desirable. Here, of course, the question "Does it work?" is most weighty.

Some builders and organists prefer double touch manual pistons: first touch will affect only the manual stops, and the second touch, by pushing the piston harder, will move the pedal stops and couplers. This overcomes the difficulty of having pedal stops and couplers affected by manual pistons at all times, something which is very annoying to some organists, and yet leaves the pedal stops and couplers instantly available, when wanted, on the manual pistons.

Many other devices placed on a console serve only to distract attention from the fact that the standard and legitimate controls enumerated above are inadequate. They cannot perform the work as well and serve only to confuse the visiting organist.

The following chapters will consider in detail the action of both the console and the windchest of the modern electric organ as practised by the various builders of America.

CHAPTER 17.

GENERAL DESCRIPTION *of the* ELECTRO-PNEUMATIC ACTION

EARLY attempts at the electric action seem to have been to place an electro-magnet inside the windchest under each pallet, which would obviously have required an enormous amount of electric current. Such a scheme was shown at the Vienna Exhibition in 1873. It was carried out by Karl G. Weigle of Stuttgart, Germany. The credit for the invention of the electro-pneumatic action is usually ascribed to Dr. Gauntlett and Dr. Albert Peschard, though the former in 1852 took out a patent covering an electric connection between the keys and the pallets of an organ which was never successfully carried out. Bryceson Brothers were the first to introduce electric action into English organs. In 1868 under the Barker patent they built an organ for Her Majesty's Opera House in London. Dr. Peschard worked in connection with Charles Spachman Barker in the improvement of the pneumatic lever.

One of the early difficulties that surrounded the experiments with the electro-pneumatic action, was the inability to obtain a good contact. The best one available in the early days was obtained by dipping a platinum point in a cell containing mercury. Other forms of contacts rapidly oxidized and became useless. Henry Willis & Sons, even as late as 1890, refused absolutely to build electric organs as they did not wish to sacrifice the artistic reputation they had built up.

In the United States, Hilborne L. Roosevelt was no doubt the pioneer in developing the electric action. Casavant Freres of Canada also did pioneer work of great importance. The partly electro-pneumatic organ which Roosevelt installed in 1884 in the Garden City Cathedral on Long Island, and which has recently been rebuilt by Casavant Freres, was a very interesting example of Roosevelt's experimenting with the electric action. The other leading American builders of Roosevelt's time, such as Hook and Hastings, Johnson & Sons, George S. Hutchings and Jardine, took small stock in electric action in those early days and throughout this period built simple tracker organs or tracker organs with a modified form of Barker lever. Jardine and Kimball did some tubular-pneumatic work quite early.

It appears that none of the early electric actions performed with quickness or reliability and all were costly to install and maintain. One who made most important improvements in the electric action was Robert Hope-Jones, who, being a skilled electrician, entered the field about 1886. In a way, he was at an advantage in knowing little concerning organs and the previous attempts that had been made to utilize electricity for this service. He made with his own hands and some unskilled assistance furnished by members of his volunteer choir, the first movable console, also stop keys, double touch and suitable bass, etc., with electric action that were a great advance on anything hitherto done, particularly in regard to speed and reliability.

Roosevelt, Farrand & Votey, and Casavant in their early electric actions employed contacts made of flat spring brass, with short pieces of platium wire soldered on. Hope-Jones introduced round wire contacts. These were first made of gold and platinum and later silver was substituted. He replaced previous methods by scientific calculations, recognizing the value of low voltage, good insulation and the avoidance of self-induction in the magnets, and was for many years probably the most important man at work on this problem.

We shall now consider specifically the elements of a successful electro-pneumatic action. This action operates in its simplest form and in the earlier models, a magnet which opens a valve admitting wind to operate the small bellows, or Barker lever, electrically. Formerly this valve was moved by a tracker leading from the key. The electro-magnet is energized by a contact that is made when a key is depressed. The closed contact completes an electric circuit which exists between the key and magnet, by means of a wire of any desired length. We illustrate this simplest form of electric action, called the electro-pneumatic lever in Figure 55.

It is necessary to give at this point some consideration to the elementary principles involved in the electro-magnet used in organ action. Every one is familiar with the horse-shoe magnet, which is permanently magnetized. This is made of hardened steel so that the magnetism that is originally placed in the magnet is retained. If the magnet is made of soft iron, preferably Norway iron, it will not retain its magnetism, though it is capable of being strongly magnetized. Consequently, this is the type of iron used for the core of a magnet employed in organ actions. The disc or armature which the magnet attracts must only be attracted when the contact is made, and the magnet must lose its magnetism, or the greater part of it, instantly upon release of the key.

Without going into the theoretical reasons why it occurs (if anyone really knows), it is a perfectly demonstrable fact that, when a coil of wire is wound around a piece of iron and a current of electricity put through this coil, the iron which the coil surrounds becomes magnetic and assumes for the moment the qualities of the ordinary horse-shoe or permanent magnet. By increasing the number of coils to a very large extent and winding these coils with wires of fine diameter a high resistance is set up to the passage of a current, so that a small amount of

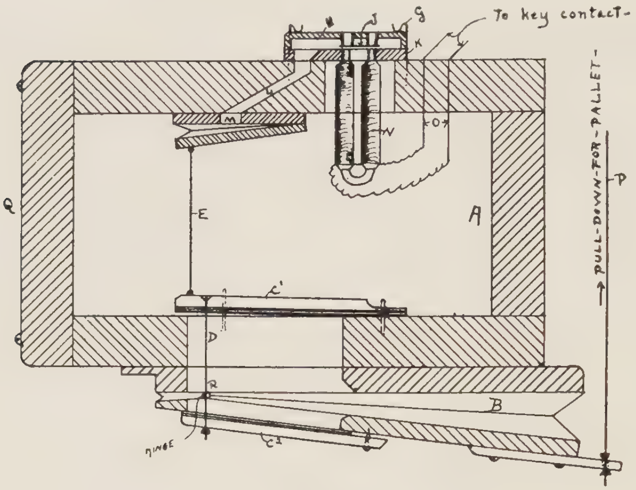


Figure 55.
Early application of the electro-pneumatic action to the slider and pallet windchest.

current is needed or consumed when it is passed through this long coil of fine wire and yet the magnetic effect produced on the iron core by this small current flowing through these many coils is quite pronounced.

The organ magnet is formed in the shape of a letter U, or approximating that of a horse-shoe magnet. In fact, some old types of organ magnet were horse-shoe in shape. Efficiency is increased by this construction as both poles of the magnet are available for attracting the armature. The disc or armature that is attracted when the current passes through the coils is purposely made as light as possible. It acts as a valve to either admit air to the exhaust hole, or to close it, depending on whether or not the armature is attracted by the magnet. Several forms of the magnet used by various American organ builders will be illustrated in later chapters.

One of the earliest forms of magnet that quite approaches what is being used at the present time, both in design and efficiency, is that invented by Hope-Jones. We show a large scale drawing of this magnet, taken from George L. Miller's work, "The Recent Revolution in Organ Building" in Figure 56. The facts are, that it was extraordinarily efficient for its day, and in some respects has not been improved upon. To explain the action, referring to our figure, we shall quote from Mr. Hope-Jones' description of its working as follows: "The box A is connected with the organ bellows and so (immediately the wind is put into the organ) is filled with air under pressure, which passes upwards be-

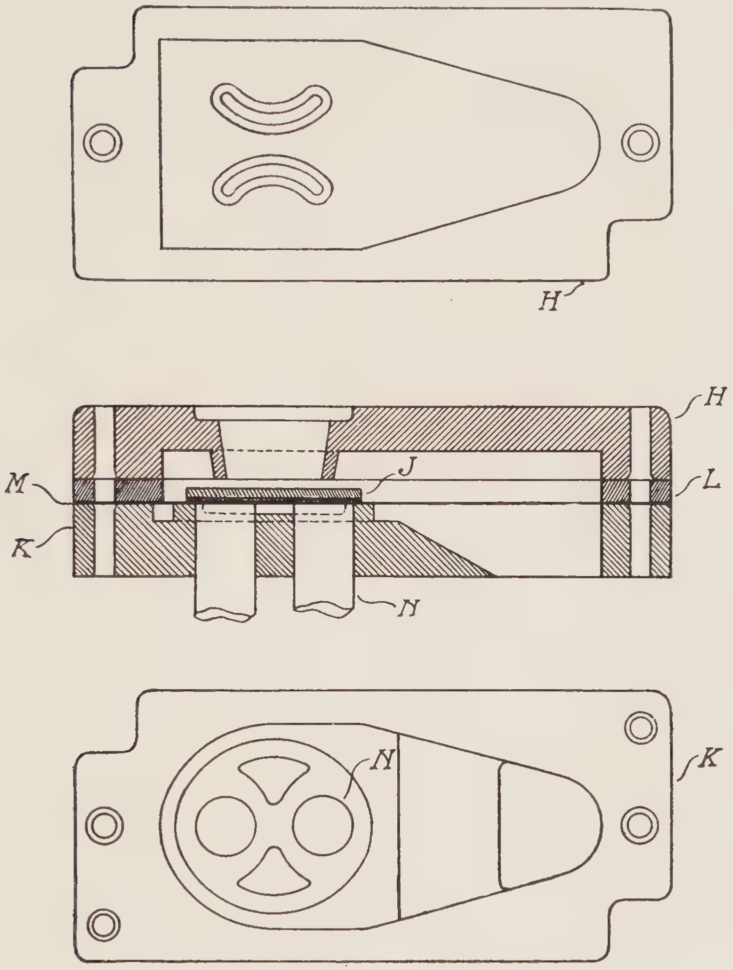


Figure 56.

Full sized views of the Hope-Jones Magnet. Top view is the removable bottom plate of the assembly. The center view is a section through the bottom portion of the magnet. The bottom view is the plate K, into which the poles of the magnet are fitted at N. J is the disc or armature.

tween the poles of the magnet N. Lifting the small iron disc J, it finds its way through the passage L into the small motor M, thus allowing the movable portion of the motor M to remain in its lower position, the pallet C^1 being closed and the pallet C^2 being open. Under these conditions, the larger motor B collapses and the pull-down P (which is connected with the organ pallet) rises.

"When a weak current of electricity is caused to circulate round the coils of the electro-magnet N, the small armature disc J is drawn off the valve-seat H onto the zinc plate K.

"The compressed air from within the small motor M escapes by way of the passage L, through the openings in the valve seat H into the atmosphere. The compressed air in the box A then acts upon the movable portion of the small motor M in such a manner that it is forced upwards and caused (through the medium of the pull-wire E) to lift the supply pallet C^1 and close the exhaust pallet C^2, thus allowing compressed air to rush from the box A into the motor B and so cause this latter motor to open and (through the medium of the pull down P) to pull the windchest pallet from its seat and allow wind to pass into the pipes.

"The valve-seat H has formed on its lower surface two crescent-shaped long and narrow slits. A very slight movement of the armature disc J, therefore, suffices to open to the full extent two long exhaust passages. The movement of this disc is reduced to something less than the 1/100 part of an inch. It is, therefore, always very close to the poles of the magnet, consequently a very faint impulse of electricity will suffice (aided by gravity) to draw the disc off the valve-seat H. The zinc plate K being in intimate contact with the iron poles of the magnet N, protects the latter from rust by well-known electrical laws. All the parts are made of metal, so that no change in the weather can affect their relative positions. R is the point at which the large motor B is hinged. G is a spring retaining cap in position; O the wires leading from the keys and conveying the current to the magnet N; Q the removable side of the box A."

This is an excellent description of one form of electric action which was applied simply to the old tracker organ windchest and Barker lever. This form has been very much improved and modified in many respects by all of our American builders, particularly with regard to the old tracker type of windchest. This has been almost wholly superseded in American organs by some form of windchest with individual pneumatics for each pipe.

Without making any direct statements or comparisons as to the specific builder or builders who make the most efficient and reliable modern action, which would be obviously unfair and unwise in a work

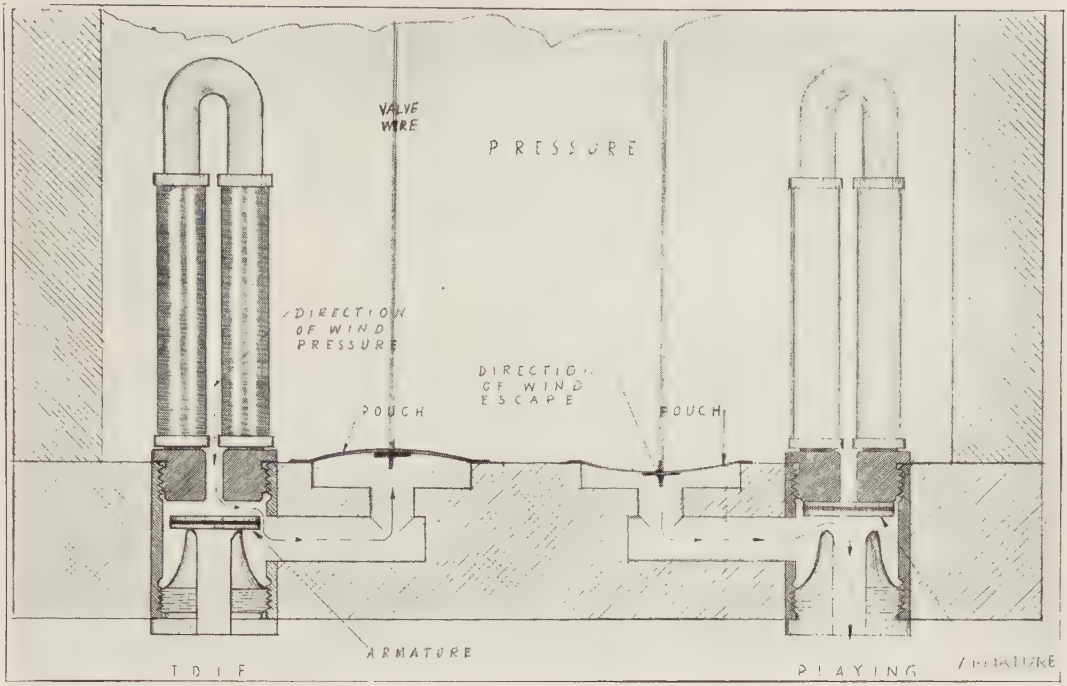


Figure 57.

Sectional view of two magnets, one, on the left shows the armature closing the exhaust port. The arrows show the direction of the wind pressure, which travels through the magnet to the underside of the pouch, thereby equalizing the pressure on both sides. The pouch will stay up, keeping the pipe valve closed, in this case, as the spring holds the pipe valve closed. The magnet on the right is attracting the armature, which in this position does two things. First, it closes the ports permitting the passage of wind pressure through the magnet, and opens the bottom of the magnet to the atmosphere, permitting the air to escape from the bottom part of the pouch, and the pressure of air above the pouch to collapse it, drawing with it the pipe valve. The drawing is of a portion of a Kilgen windchest, kindly furnished by Geo. Kilgen & Sons. This drawing is one of the clearest expositions of the exact function of the magnet, with its armature acting as a two way air valve, that has ever come to my notice. It will repay the study of the uninitiated. From it may be obtained a very clear idea of the function of any magnet and pouch, as made by any builder, as the principles are the same in all cases.

of this kind, it is perhaps advisable to state what is most desirable in an electro-pneumatic action. Then details will be furnished as to just how the various builders accomplish these ends and let the reader judge for himself which style of action he considers the best. The two qualities that are most desirable in a modern organ action are 1. Reliability, and 2. Speed; that is, quickness in attack and repetition.

There is, of course, a considerable similarity between most of the action work of our best builders. As a matter of fact, there is not a great deal of choice. Nevertheless, certain of our builders have gone into some matters more carefully than others and have reached a higher degree of perfection. Nearly all modern organ actions are electric, or more properly electro-pneumatic. It should already be clear that compressed air which is available in every organ is used for power. Wind pressure and electricity are employed to transmit the playing and other impulses. It can readily be seen that electric transmission aids the responsiveness of the action, as the impulses are transmitted with the velocity of light. Such transmission also aids in reliability because the coupling, switching, and transmission is done on prepared circuits, some permanent and some temporary. A permanent electric circuit with soldered joints is absolutely reliable and durable. A temporary one is also provided that the contacts or points of closing and opening the circuit are reliable and durable.

The electric organ action is operated on low voltage, and direct current is necessary. Organ magnets will not operate on alternating current. The voltage varies between eight and fifteen with different builders. In years past it was quite a problem to secure a reliable source of this kind of current. It was usual to employ storage or other batteries in early actions. There are now on the market a number of very reliable generators capable of producing the low voltage current necessary in organ action that are generally attached directly on the same shaft with the large motor that turns the fans for supplying wind to the organ. This method of directly connecting the generator on the same shaft eliminates all trouble from belts and slipping and other generator troubles that can occur when the generator is placed separate from the blower. Owing to the very uneven and sudden demands that are made on generators used for supplying current to organs, it has been a matter of considerable difficulty to design a generator which would meet these requirements. When an organ is not being played with the generator going at its normal speed, there is little, if any, demand upon the generator for output of current. When a heavy chord is struck upon the organ there is a sudden demand for the entire output of the generator and it must be instantly available, or the voltage will drop

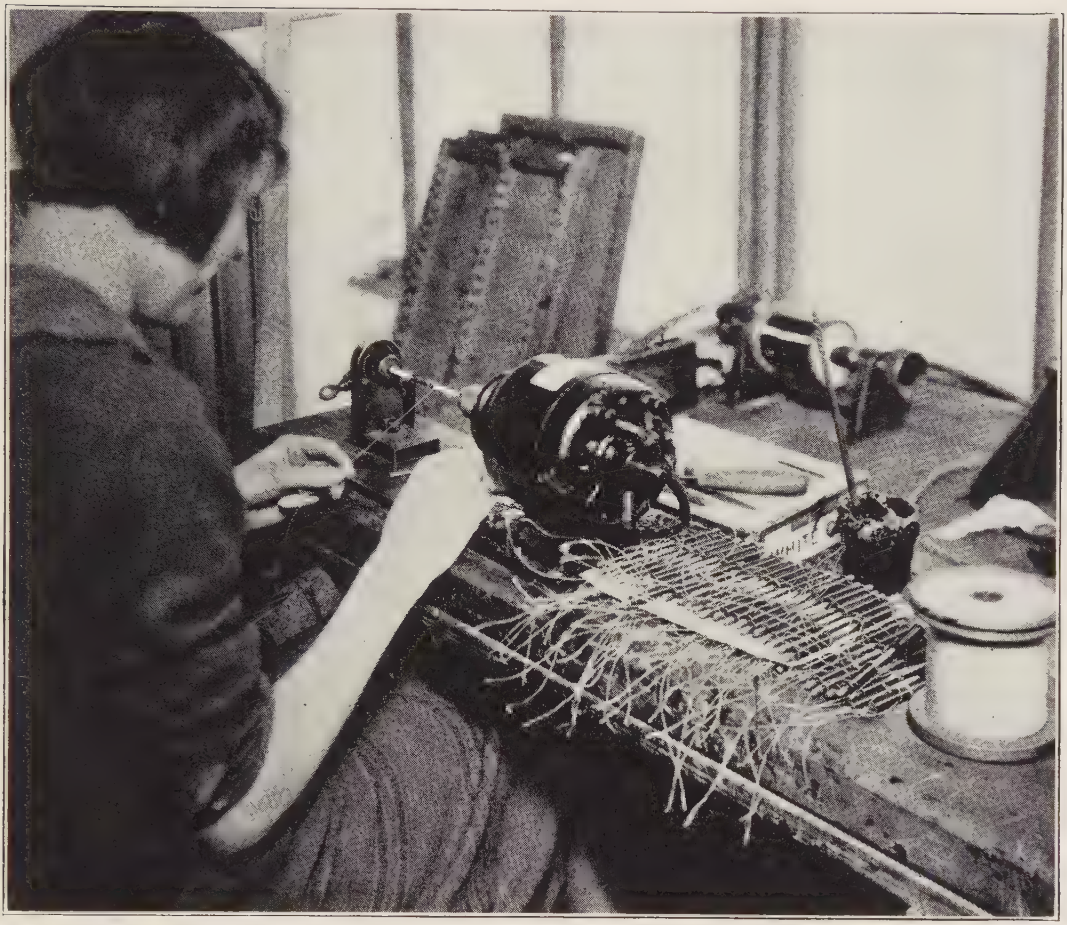


Figure 58.

Winding the magnets used in the Kilgen organ. The soft iron cores are placed in a lathe. After paper insulation has been applied to the core, it is wound with a proper number of turns of enameled magnet wire. The iron cores are then bent into a U shape in a press, and are ready to be assembled in the magnet base.

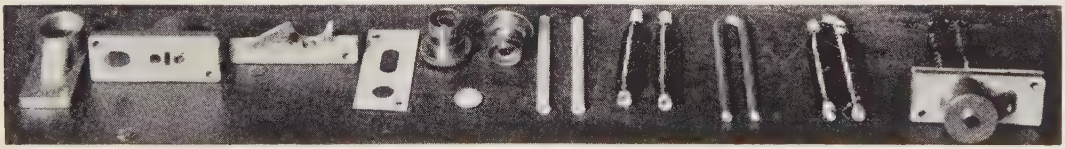


Figure 59.

Parts of the Moller magnet. From left to right, the parts are: front and bottom views of the base, blotting paper packing where base is attached to the windchest, front and bottom views of armature base, with armature or metal disc in foreground. This part may be readily unscrewed to get at the armature for cleaning or adjusting. Next, two paper straws on which the coils of magnet wire are wound in a lathe as above, and then slipped on to each side of soft iron core, that has previously been bent to shape in this case. The last item is the completed magnet.

to such an extent that the magnets will not work properly.

An unreliable source of low-voltage current has finally been discovered to have been the reason for the unsatisfactory performance of older electric actions. Failure to discover this fault for years delayed the cause of the electric organ in England. Some of these old organs have been rehabilitated and new generators of an improved type installed, whereupon the old electric action has been found to function perfectly. It will, therefore, be seen that a reliable source of current is perhaps the first and prime essential of a successful electric organ action. Happily, such a source may now be taken as a matter of course and need not be considered further.

It is interesting to note, however, that many of the troubles that earlier electric actions encountered, giving them the name of being unreliable, was not so much due to faulty design or construction of the action itself as to the current supply being unreliable and faulty.

We shall now trace the operations of the action following the electrical impulse created when a key is depressed through the various steps in the action until the pipe sounds. An analysis of all these operations will give a more general idea of what the electric action consists of. We shall also, at the same time, consider in some detail some of the features that go to make this source of operation reliable and efficient or the contrary.

When a key is depressed, it makes either a single or a multiple contact. That is, it closes or completes one or more series of electric circuits. On account of the coupling system in modern organs whereby all of the separate divisions of the organ can be collected together on the Great keyboard or different combinations of divisions can be made on any of the other keyboards, it is necessary for the key to close simultaneously a rather large number of circuits. This is accomplished in one of two ways, either by mounting a number of contacts directly on the key itself, or having the key mechanically operate in one of a number of ways (described later) a series of contacts which are not directly attached to the key. Or the key itself need only close one circuit which leads to a relay mechanism in the organ. This mechanism when operated will close the desired number of contacts.

The first method described is always preferable whenever it can be used because it dispenses with the relay mechanism and permits of a closed electric circuit from the key to the pipe chest with no relay operations in between which must inevitably slow down the train of operation to a certain extent. In organs which have a large number of stops of the unit variety where a large number of separate contacts must be made, one for each magnet, it is frequently imperative to introduce a relay mechanism, if a sufficient number of contacts cannot be directly operated by the keys themselves. With most church organs, quite enough contacts can be readily placed on the keys for operating the various couplers, each of which requires a separate contact for every key. The distance from center to center of the keys is approximately ⅝ inches, so, in addition to possessing reliability and durability, these contacts must be quite small to fit in such a small space. They also have to be of very sensitive and gentle action in order that the organist's sense of touch may not be disturbed, when a greater or lesser number of contacts are "made" by depressing the keys.

The number of circuits completed and broken by an organ key during a year's playing is almost incredible in cases where the organ is used for several hours a day (as was always the case with theater organs and sometimes with church organs). The ideal contacts, therefore, must not only be reliable but they must "make" every time and the first time, even after long periods of disuse. The chief problem in this matter is to build them in such a way and of such material that they will stay clean constantly. Dirt and dust settling from the air may cause the contact not to "make"; or, fouling of the metal, caused by electrolysis due to arcing at the contact, when the circuit is opened may cause unreliable contacts. The first difficulty is overcome by making the two elements of the contacts from suitable material and placing them so that the axis of one is at right angles to the axis of the other, thus securing always a point of contact, and eliminating a dust-collecting flat plate.

The motion of the key in all properly designed electric organs is such that the two contact elements form a rubbing touch which makes the points self-cleaning. There are two ways of eliminating the difficulty caused by arcing of the contact point, first, by finding material that is as impervious to corrosion as possible; and second, by designing a magnet that will operate with the smallest possible consumption of current in order that the electrical load may be reduced to a minimum. Again, magnets of which there are many different types (some of these are illustrated later) have a varying degree of resistance to the passage of current. The resistance varies in different makes of magnets, averaging around 100 ohms, though some builders make a great point of the fact that the resistance of their magnet is much greater than this, up to 400 ohms. The higher the resistance the less current consumption for each magnet and the less arcing or burning of the contacts is likely to occur, provided the same voltage is employed in each case. Other things being equal, therefore, a magnet of high resistance is preferable to one of low resistance though, if the resistance be too high, the magnet will not have as great pulling power on the small disc which it is designed to attract.

There are arguments on both sides of this question, and the undoubted advantage of a small current consumption is sometimes offset by the failure to accomplish what is intended quite as well as if a larger current consumption is permitted.

We now come to a highly disputed point in present day organ building, the question of the most suitable material for contact purposes. A good many of our leading builders use nothing but silver wire for this purpose. This is what was generally employed by Mr. Hope-Jones in the organs which he built.

Only three metals; platinum, tungsten and silver, will stand up under the following laboratory test: A reciprocating device designed to reproduce the motion of the keys has mounted on it contacts of different design and many different metals including three alloys of silver, two alloys, of phosphor-bronze, tungsten, platinum, German silver, "meteor" metal and others. This test was run constantly for a period of six months at a rate of two hundred and forty contacts per minute, forty-eight hours a week, with each contact loaded with coils consuming one-fifth of an ampere. As has been noted, the only three metals to stand up under this test were platinum, tungsten and silver. Silver may be obtained in a suitable alloy so that it has a certain amount of spring when made into wire, an essential quality for any contact to have. Phosphor-bronze is also employed for contact purposes by several of our leading builders and the chief argument which is used for this practice is that phosphor-bronze may be had in wire with much greater spring qualities than is possible with any alloy of silver that does not more or less nullify the excellent conductivity of the silver itself. Phosphor-bronze contacts, when carefully designed and all the workmanship perfectly carried out, seem to answer the purpose about as well as silver wire contacts, though in very damp weather phosphor-bronze contacts will not "make" the first time, whereas silver will make a contact at all times and under all conditions.

It is indisputable that silver is a better conductor of electricity than other metals available in commercial quantities, but the qualities of additional springiness which, for instance, phosphor-bronze contacts possess, may in large measure compensate for its smaller degree of conductivity. I prefer silver wire contacts myself and do so because of the engineering reasons given above for using them in preference to any other metal at present known or available.

To proceed with our description of the operation of the electric organ action: From the key contact, the current impulse flows through prepared electric circuits. The circuits are made up into cables. These are usually partly exposed and partly in iron conduits. They should be durable and damp proof. For insulating, the different wires are usually double cotton-covered impregnated with paraffin. The cables run to the organ proper and the various wires are soldered to a union or junction board. From this point, additional cables are provided also soldered to the union board that connects directly with the magnet action box and the current flows into a magnet coil. The reason it is of such importance to solder all the joints that occur between the key contacts and the magnet in the electric action, is that only low voltage current is employed. A small amount of corrosion on the copper wire where a joint or splice is made in it may render the joint a non-conductor of electricity, as this corrosive material is in reality a dialectric. There is not sufficient voltage to jump across this corrosion and a silent note may result. Some builders use spring clips for joining wires, with good results. Corrosion may not occur until the organ has been in use for six months or a year. Then silent notes will develop in various parts of the action if any of the joints have not been properly soldered, which process at once makes the joint permanent and not subject to corrosion. It is, therefore, of the utmost importance that all joints or splices of the cables be soldered at all points, or otherwise permanently joined. It would be an enormous job to determine where the circuit was dead if all joints had to be examined after the organ was installed. When the joints are systematically soldered all such difficulties are removed once for all.

A magnet is placed wherever an action or operation is desired. The magnet merely transforms the electric impulse into a pneumatic one by raising a small iron disc, thereby exposing an exhaust hole starting the train of the pneumatic action, as previously explained. Very little energy is required to lift this armature and the electric impulse around the magnet coils does this with extreme rapidity. Builders are not agreed as to whether the motion of this armature should be permanently fixed at a definite distance. Some builders insist that this is the only way a magnet should be built, while others consider it to be an advantage to be able to adjust the motion of the armature for different conditions and wind pressure. These are the chief features of the electrical side of the organ action.

To sum up, the reliability of the electric system is primarily dependent upon four distinct factors:—1. A reliable source of low voltage electric current, 2. a reliable contact point, 3. a reliable magnet and 4. reliable transmission system.

Trouble is most frequently caused in a magnet by dirt blown under the armature and thereby preventing its proper seating or closing. When this occurs, the same effect is produced as if the magnet were permanent in action and the note is caused to sound constantly or "cipher" until this dirt is removed. The possibility of this is minimized by some builders who construct the magnet with a thin gauze glued over the air ports which will catch stray pieces of dirt before they become imbedded under the armature seat. Whether this practice is of any great value is something of a question.

When the electric impulse arrives at the magnet, the action then changes to pneumatic. The armature, which up to this point has been viewed from the electrical side, should now be considered in regard to its function, which is in reality that of a pneumatic valve, which exhausts a small bellows or pouch. The latter has a large valve attached to it which this pouch opens. By the opening of this large valve the pipe valves themselves are operated through fixed air channels. These primary valves when complete weigh from one-fourth to one-half an ounce. The pipe valves are in many standard actions mounted upon diaphragms or pouches and are operated by the motion of these diaphragms, the average weight of which is about one-tenth of an ounce. Most of the builders do not attempt to operate over six to ten sets of pipes from one primary valve, though with the pitman chest this is not important for obtaining speedy action. The total weight that has to be displaced when a key circuit is closed is the weight of one armature, between .023 and .050 of an ounce, one primary valve assembly weighing about one-fourth of an ounce, which operates six to ten pipe valve assemblies, weighing one-tenth of an ounce each, or a total combined weight of all this mechanism of about an ounce. The greatest movement of any valve is about three-eighths of an inch. This is the largest amount of material moved individually because each division of the organ has its separate action. These figures apply to manual chests where the greatest speed of action is important. Other types of electro-pneumatic organs contain pneumatics which are partly made of wood, some having the valve mounted directly on the bellows, others having the bellows operate pivoted levers of all kinds on which the valves are mounted. All these various types are illustrated hereafter in this work.

It should be observed that with the small amount of wind pressure utilized in organ building, the additional weight and friction involved in using pneumatics with wood and levers in their construction affects somewhat adversely the responsiveness of the action. The leather on these bellows pneumatics, by its very construction, has to be folded in creases which causes these then to wear out more rapidly on the lines of the creases. The pivots in the levers will also work loose in time, and have to be replaced. This is all eliminated by the use of the round pouch, or diaphragm which moves the pipe valves. There is absolutely no creasing of leather whatever and no additional material of any kind to move except the valve itself, in this type of pipe valve. The pouch or diaphragm pneumatic with the valve attached to the pouch was developed by Casavant Freres of St. Hyacinthe, Canada.

It may appear from this description of what an electric organ action is designed to accomplish that the two primary requirements it must have to be satisfactory, namely, 1. reliability and 2. speed, are best obtained in the manner we have outlined though as will be seen later the diaphragm or pouch chest is by no means the only type of action that will accomplish these results. It is the type of action, however, that is used by a majority of our leading builders and seems to be steadily becoming standard. By this the writer does not for a moment wish to have it appear that the widely varying types of action made by other builders which may be entirely different in every respect from that of the action just described are not satisfactory for action purposes. These other types of action have many points in their favor, though I believe it has been established with considerable certainty that no action is as speedy as the pouch or diaphragm pneumatic, combined with some form of the pitman stop action. This type of action has a speed greatly in excess of that with which the lower pipes of the manuals can be made to speak. There is no great advantage in having an action faster in its operation than the pipes can be made to speak. The craze for excessive speed has been engendered quite largely by the demands of theater organists. Legitimate demands for speed are met by nearly all the types of action to be described presently.

CHAPTER 18.

TYPES *of* MODERN WINDCHESTS

THE "UNIVERSAL AIR CHEST"

A FORM of windchest and action that is in use at the present time which presents many unique features is the one known as the Universal Air Chest, invented by Mr. John T. Austin.

The first organ in New England that was built along these lines was installed in the Fourth Congregational Church of Hartford, Conn., in 1898. The installation of this organ created such widespread interest that it resulted in the formation of the Austin Organ Co. of that city. Mr. Robert P. Elliot was largely instrumental in the formation of this company, though he has had no connection with it for many years. Prior even to 1898 the Clough & Warren Co. of Detroit had made an airchest of somewhat similar design while Mr. Austin was associated with them.

The Universal Air Chest is the first to be described in this work because it is one of the simplest and easiest forms of electro-pneumatic action to explain. It combines some features of the tracker organ along with the most modern application of electro-pneumatic motions.

It is possible that a general work should not devote so much space to the description of a highly specialized form of action used by only one builder, but this firm has nearly two thousand organs to its credit, among them some of the largest and most important in America, which fact alone seems sufficient reason for a detailed description of the system that has been consistently employed during these years on all organs which the Austin Organ Company have built.*

---

*Note: It is not the author's intention to praise one builder at the expense of another, but in all fairness, it seems just to give credit where credit is due, particularly with regard to original inventions in organ-building is this true.

I realize that general statements are sometimes dangerous to make, but I believe it is generally agreed among the organ builders of this country that Mr. John T. Austin is one of the most ingenious and clever men that have given their attention to mechanical matters relating to the organ during the past thirty or forty years. One of the distinguishing features of the Austin organ both in regard to air chest mechanism and console mechanism is its entire originality. Nearly every detail has been invented by Mr. Austin or by his brother, Basil G. Austin. At no point along the line have they been content to use the ideas of other builders, but have originated a vast number of organ mechanisms of all types.

Some American builders have copied as closely as possible many of the details of the Austin console, though no other builder has apparently cared to copy the chest mechanism. The Austin Organ Company has doubtless more patents covering organ mechanism than any other builder in the country. Experience has proved that these patents are not particularly successful in avoiding copying of ideas by other builders. Mr. Austin himself, when told that other builders have appropriated certain of his ideas, is very "easy-going" about the matter and usually replies, "Oh, well, by the time they get to using that, I will have something better."

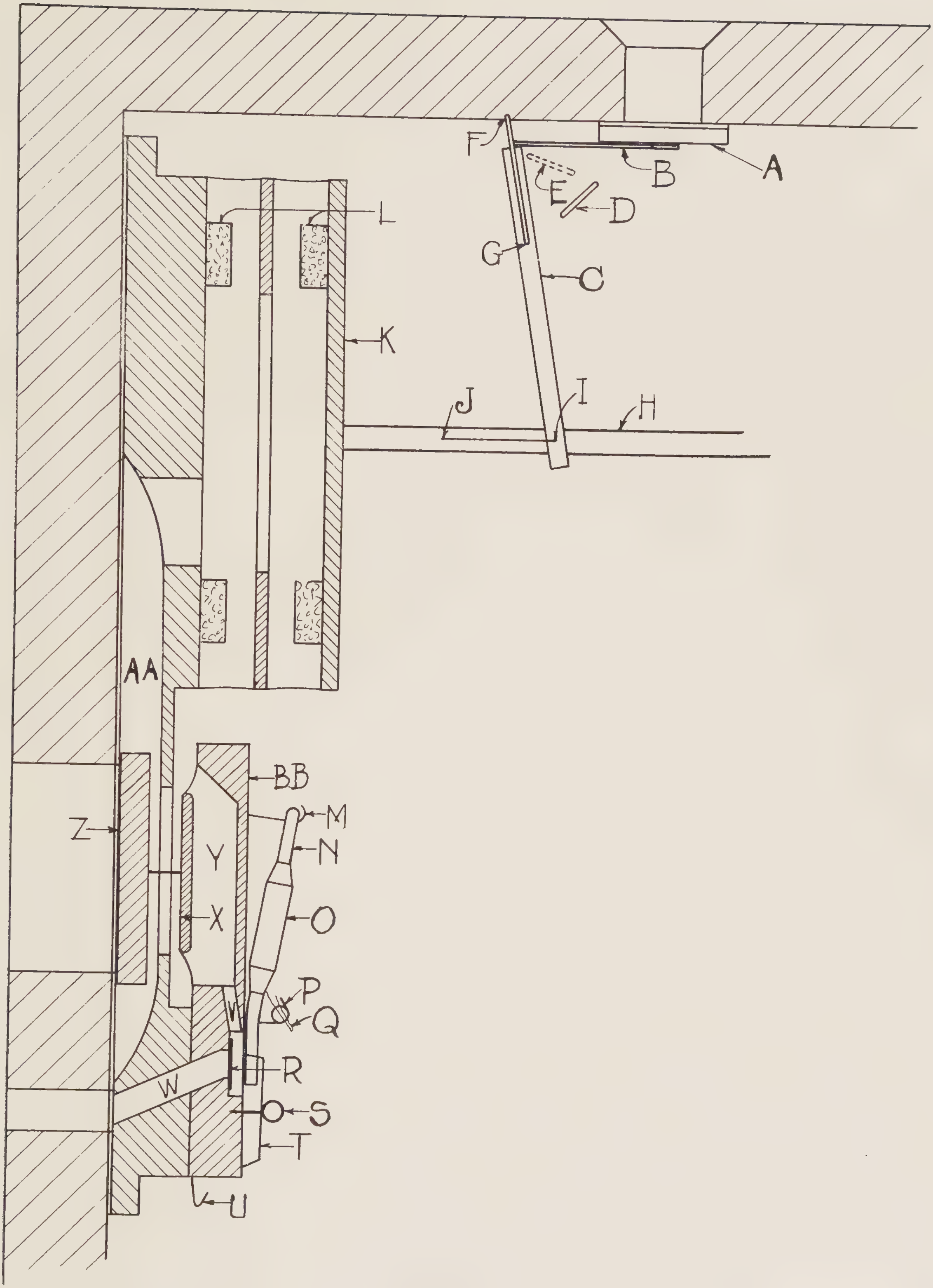


Figure 60.
Section through a portion of the Austin Air Chest.

At the time the Universal Air Chest was invented, electro-pneumatic and tubular pneumatic organ actions, as made in this country, were largely unreliable and caused a great amount of trouble. Windchests were frequently built so that ready access could not be had to the valves and magnets or other mechanism liable to derangement. It frequently necessitated the removal of the pipes from the top board and unscrewing a vast number of screws to get at the mechanism. This was a long, laborious process. Mr. Austin has told me of working on such windchests, and of his exasperation and annoyance at being unable to tell whether the trouble had been rectified until the top board was screwed into position again and the pipes replaced and then perhaps to find that the trouble had not been remedied, and all his work had to be done over.

To overcome these difficulties entirely, Mr. Austin conceived the idea of a large air box which could be entered with the wind inside the box. This box is like an air-tight room, ordinarily about six feet high, with one side a movable reservoir, and in the ceiling, rows of holes covered with valves, with the pipes directly above these valves. It is impossible to have the slightest variation in pressure in this chamber. There is an imaginary conductor to every pipe, as large as the whole head of the reservoir itself. The chief features of the Austin Air Chest are its easy accessibility and absolutely steady wind at unvarying pressure supplied to each pipe.

At the time the Austin windchest was invented, the reasons for its superiority were more manifest than at present. Then the unreliability of the usual pneumatic windchest and the difficulty of making adjustments therein, coupled with the unsteadiness of pressure, were much greater than they are now.

Practically all of our American builders have improved the other forms of electro-pneumatic windchests to a point where they are extremely reliable, and at the same time are more accessible in case adjustments are required. With the modern system of constructing deep air boxes and ample conductors from a large number of reservoirs or regulators, a perfectly satisfactory and steady pressure is obtained from any good windchest built along conventional lines. The Austin Air Chest is the only one of its kind being built at present. For that matter, it is the only one that has ever been built successfully. The Austin mechanism, when compared with other modern windchests is extraordinarily simple.

By an examination of Figure 60 it will be observed that the pipe valve "A" consists merely of a small metal disc of the proper size for the hole to be covered (varying from a disc covering a large

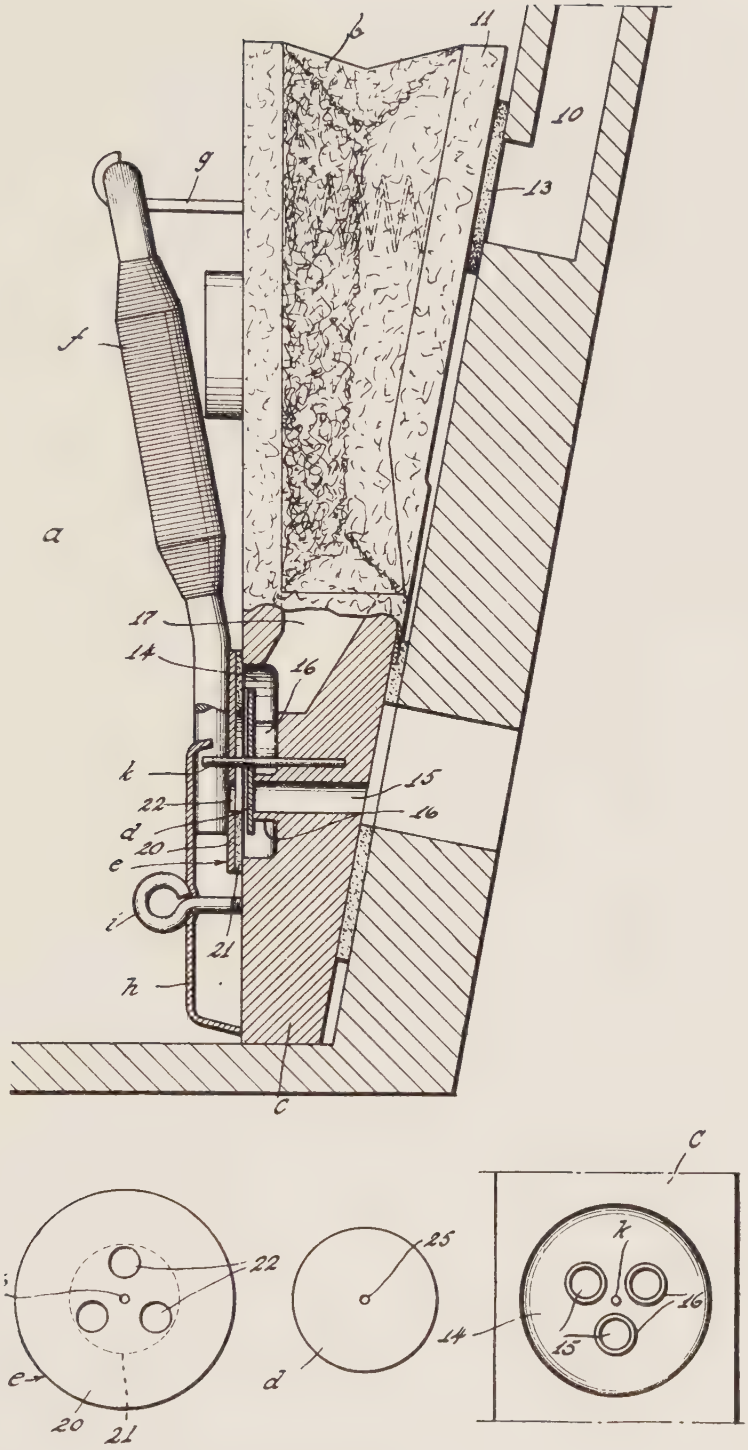


Figure 61.

Enlarged view of the Austin magnet and small pneumatic. The lower left figure shows the tripod construction of the air ports, while the lower centre figure shows the armature disc. This is guided by a centre pin, thereby eliminating friction on the sides of the armature. The small pneumatic may be adapted to exhausting a larger power pneumatic, or in the case of small pipe valves on unit chests may be used as the pipe valve direct.

hole admitting wind to a bass pipe to much smaller discs for the treble pipes). The metal discs are covered with felt and leather so that a soft air-tight covering is provided when the discs are in the closed position. A wire B, is riveted through this disc in the shape shown in our drawing to which is attached a little strip of wood C which is pivoted a short way below its top. The bent wire B is pivoted at F. The bottom of the wood strip C is attached by means of another wire at I and J to a long strip of wood or tracker H. The tracker runs across the entire width of the air chest, having connected to it as many pipe valves as there are stops or sets of pipes planted on the chest. One end of this tracker has a coiled spring attached to return it to its normal position. The other end of the tracker is attached to the power-pneumatic K which draws the tracker "H" to the left when it is collapsed, by exhausting the air from the pneumatic bellows through the ports AA and Z to atmospheric pressure. When a key is depressed, the valve Z is opened by means of the magnet M, whose action will be later described. When the tracker is drawn to the left by the collapsing of the pneumatic K, all the wooden strips "C" are rotated on their pivots at G, without opening the pipe valves if no stops are drawn.

The stop action consists of a metal bar 1/16 of an inch thick by ½ inch wide, which runs the entire length of the chest at right angles to the trackers. This is pivoted, and is shown in our illustration in both of its positions, "off" position at D and the "on" position, in dotted lines at E. It is caused to assume its "off" and "on" positions by means of a power pneumatic mounted at one end of the chest. When the stop is in the "on" position, the pneumatic causes this long metal bar to assume the position shown at E. When the stop action bar is in position E, and the strips C are moved by the tracker, the stop-action bar acts as a fulcrum, and the strips C can no longer rotate freely on pivots G but must cause the pipe valves to be drawn open whenever the tracker H is moved to the left. All of this mechanism can be seen in actual operation with the pressure on, by entering the air chest, and any small adjustments can be made, such as proper seating of the pipe valves, with great ease.

It will be observed that there is only one set of pneumatics for each note on the windchest instead of one pneumatic for each pipe valve. This simplifies the mechanism. Should releathering of the pneumatics become necessary, only one set need be redone as compared to five to ten times that number in the regularly constructed windchest. This is not very important however, as the pouch or diaphragm pneumatic employed in the modern windchest by many builders is not subject to the wear of the bellows with fold type, that Austin uses. Pneumatics tend to wear

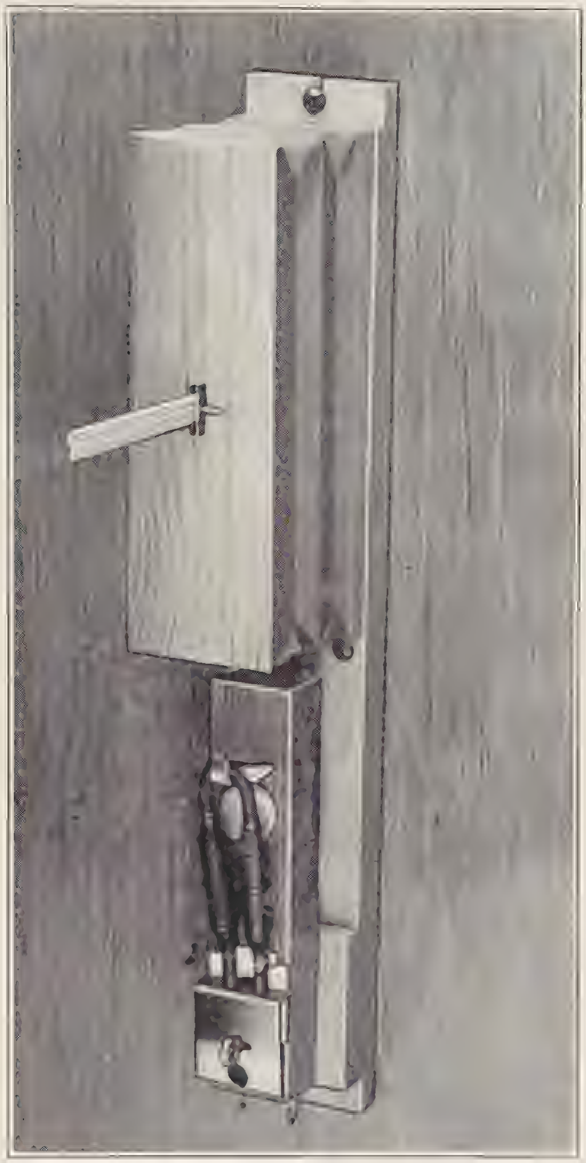


Figure 62.

Complete electro-pneumatic power unit employed by the Austin Organ Co. A portion of the "tracker" or strip of wood is shown. This is attached to the power pneumatic and runs across the entire width of the air chest, to which all the pipe valves belonging to one note are fastened. Figure 60 shows a sectional view of this same power unit. There is one of these units for each note on the manual keys. They vary in size, becoming larger, and consequently more powerful for the lower notes, which require more power to operate. If there are ten stops on the air chest, controlled by one manual, there will be ten pipe valves attached to the tracker, that will be opened by one power pneumatic.

out in the folds much faster than when they are not folded. For this reason a diaphragm pneumatic will out-wear a bellows pneumatic. Leather will rot away whether it is used or not after thirty or forty years. In any case, the thin, delicate leather required for organ pneumatics of any kind has a limited life.

The construction of the Austin Air Box is such that changes of atmospheric conditions do not affect the air-tightness of the box. To withstand the considerable pressure of the air, it is strongly braced at all points. The wood sidewalls have wide joints left between the various strips which are made tight by leather and rubber cloth. This construction allows for expansion or shrinkage in the wood without opening up any joints. The top of the air chest is made of a series of wooden bars about three inches wide and two inches thick through which the holes for the pipes are bored. The pipe valves are attached before the bars are placed in position. If the pipes are small in scale they will be placed in a single row on one of these bars. If of wider scale, two bars will be used, placing the pipes alternately. If a very wide scaled stop such as a large Flute or Diapason, three bars are used. The system of using a standard sized bar is more economical to manufacture and yet has great flexibility in accommodating any size pipes that may be required. The pipe bars are then secured to the frame of the air box at appropriate distances apart to give ample speaking room for the pipes, and the spaces between them are filled in with rubber cloth to make the entire top of the chest air-tight.

The reservoir mounted vertically instead of horizontally forms one side of the air box and is termed an "Expansion Board". Such a reservoir must necessarily rely on springs for regulating the pressure as weights can not be used. The Austins were the first to use springs exclusively for reservoirs although the idea of this use probably originated with Mr. Hope-Jones, as stated in our chapter on the Wind Supply for the Organ.

Formerly the wind pressure in the Austin Air Chest was invariably so steady that it was impossible to shake it with any form of valve tremulant or any other means. Later Austin Organs have been enabled to produce a fine tremolo effect by an ingenius remodeling of the air box. The upper portion is panelled, thereby separating it from the main air chamber and it is supplied with air by means of a very large opening that can be shut off with a damper. When the tremulant is not in action, this damper remains wide open and all of the advantages of the Universal Air Chest are still available. When the tremulant is drawn, the damper closes automatically and wind is admitted to the panelled sections by means of a long pipe which causes the air in this

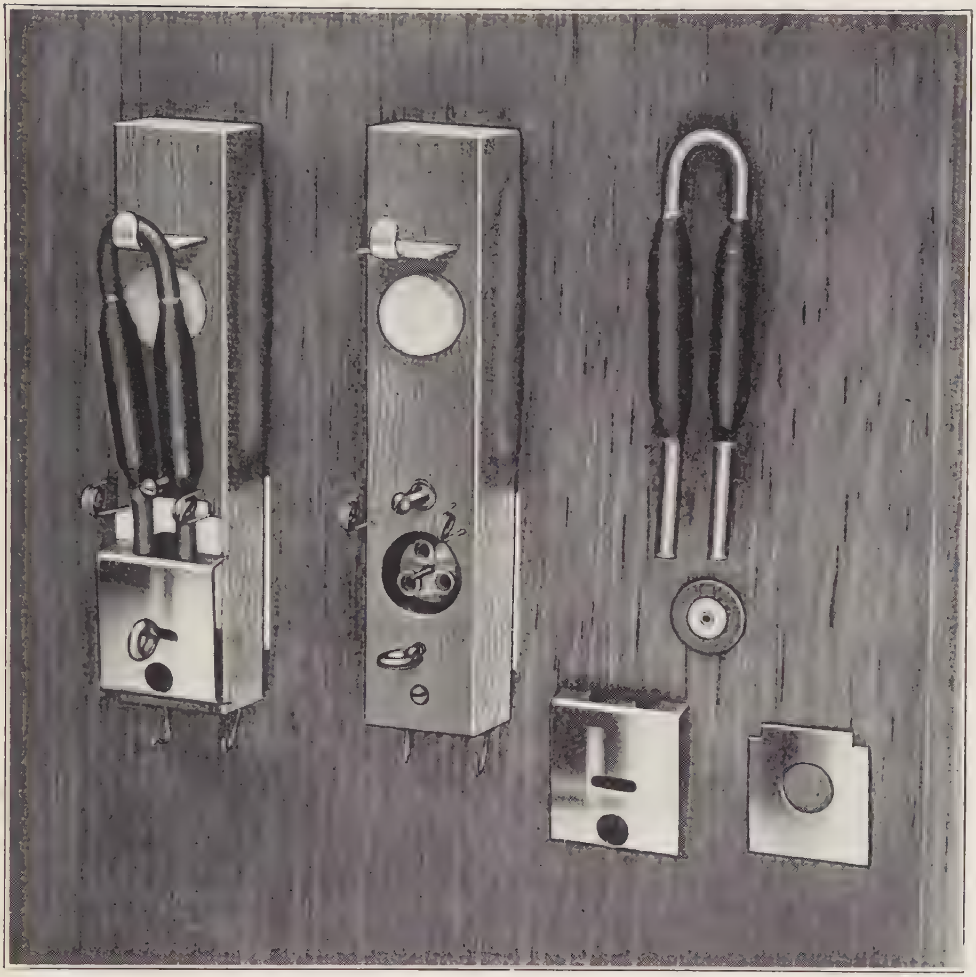


Figure 63.

The left hand photograph shows the Austin magnet and small pneumatic that upon being exhausted by the magnet draws open the exhaust valve of the larger power pneumatic. Compare this with Figure 62, which shows the relation between this section of the complete unit and the power pneumatic. The centre photograph is taken with magnet removed. This is accomplished simply by turning the thumb screw at the bottom of the assembly, and removing the brass retaining clip. The armature may then easily be removed as shown in the third photograph.

section to become sufficiently elastic to be effectively shaken by the tremulant. In this manner a tremolo may be obtained quite equal to that possible with the ordinary type of windchest construction and a real weakness in the Universal Air Chest is effectively overcome.

Before this construction was adopted a tremolo of a certain kind was obtained by placing a large board three feet long and two feet wide, pivoted in the center immediately above the pipes themselves. This board was rotated by an electric motor at a speed that caused a pleasing undulation to the tone of the pipes, much on the same principle of the fan tremolo in a reed organ.

Some organists consider this latter tremolo superior to the usual pneumatic tremolo; others like myself, greatly prefer the valve tremulant and fortunately it is now possible to suit either taste.

The complete operation of the power pneumatic that draws the tracker operating the valve mechanism may be described as follows: There are two parts: 1, the power pneumatic that actually draws the tracker; 2, the electro-pneumatic valve mechanism that exhausts the air from the larger power pneumatic. The latter mechanism now employed was patented May 24, 1926, and is an improvement on earlier actions. It is shown in detail in Figure 61, a side view. Our references, however, are to Figure 60, which shows a cross section through a complete power pneumatic unit. These units may be readily mounted or demounted from the air chests by the means of two screws, in case releathering or replacement is necessary.

For further clearness, Figure 62 and Figure 63 are also shown, which are actual photographs of the complete power pneumatic and of the magnet portion. If the operation of this unit is once clearly understood, the principle of many modern organ actions is explained. All the action parts used in the Austin Organ including stop action pneumatics, pedal note pneumatics, which are individual (one to each large pipe) are all built on the same principle. Other moving parts of the Austin action are all mechanical and for this reason the Universal air chest action may be termed a combination of the tracker or mechanical action with the most modern electro-pneumatic developments.

Examining Figure 60, it will be seen that when the magnet O is energized, it draws the armature R toward the poles of the magnet thereby uncovering the exhaust port W. The small pneumatic BB is thereby exhausted through the channel V, drawing the exhaust valve Z of the large motor pneumatic off its seat and simultaneously cutting off the supply of air into AA. This permits the air contained in the large pneumatic K to be rapidly exhausted through the air channel AA, because the exhaust port uncovered by Z is of generous size. The power

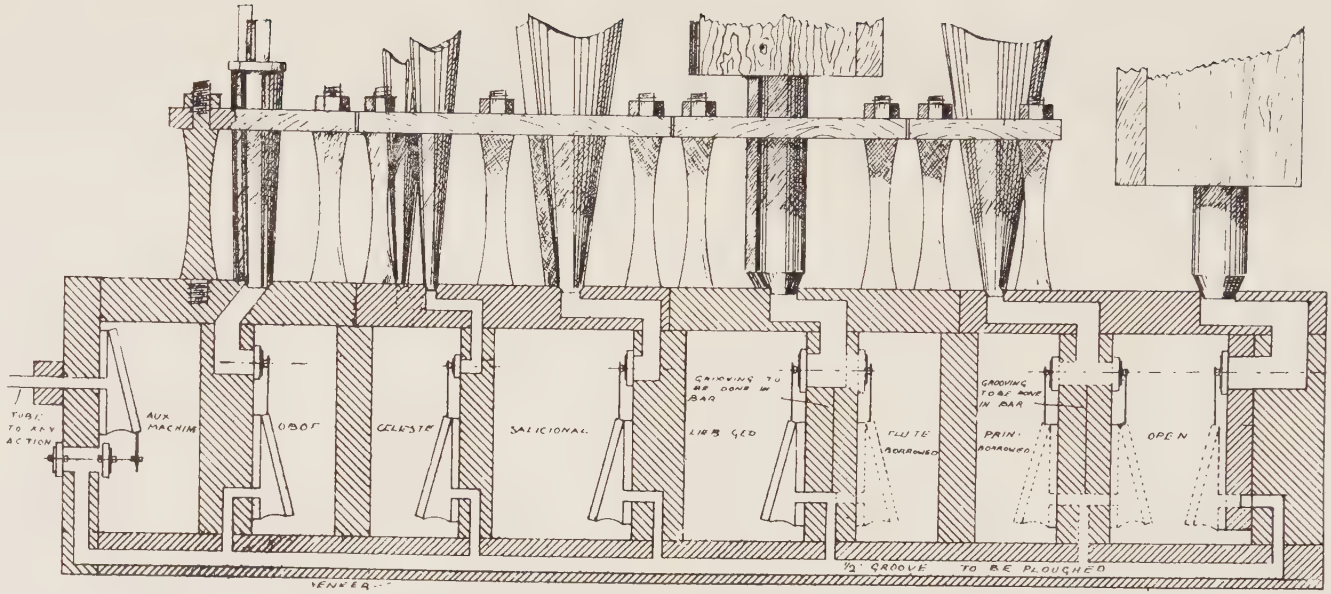


Figure 64.

A sectional view through an original and authentic Roosevelt windchest, with tubular pneumatic action. This was one of the first windchests to be built with individual pipe pneumatics. Its operation is described in the text. (From W. & T. Lewis, "Modern Organ Building.")

pneumatic K is prevented from closing too far by the felt strips L.

Remembering that we are looking at the interior portion of the air box, it is evident that the exhaust ports uncovered by the magnet and the larger valves open directly to the atmosphere. When the armature is allowed to return to the position shown in Figure 60, wind again flows through V into Y permitting valve Z to close and wind also flows through AA into the motor pneumatic K, which opens, bringing all the action back to its normal condition. The success of this action lies in the fact that no channeling and only one pneumatic is required for each note on the keyboard (not each pipe on the windchest), and the sureness and rapidity with which this motor pneumatic can be made to operate by the system just described.

WINDCHESTS WITH VENTIL STOP ACTION AND INDIVIDUAL PIPE VALVE PNEUMATICS

We have described in our chapter on the History of the Organ Action, the manner in which the Barker Lever was applied to the old type of slider and pallet windchest. In this form of action the valves that admitted air to the Barker Lever might be opened by mechanical means, as in the tracker action, or pneumatically by means of the tubular action, or electrically. But whatever action was employed for operating the Barker Lever, the stop action was controlled by sliders in the same manner as it had been for hundreds of years before.

In large tracker organs built in France (and for the most part they are still in use), the wind is shut off from certain divisions by means of ventils or large air valves that are operated by either stop actions or foot levers. In this manner several stop knobs (usually the Reeds) may be drawn at any convenient time and not be brought into action until the ventil is open that permits air to enter the windchest, on which the pipes are planted. Also, it was customary in nearly all tracker organs, so to build pedal windchests that their stop action might be controlled by means of a ventil.

Thus it is apparent that the ventil was used for stop action purposes long before the modern windchest was invented. Hilborne L. Roosevelt was the first in America to introduce individual pipe valve pneumatics in a windchest that operated in connection with a ventil stop action. A drawing of the original and authentic type of windchest known as the Roosevelt Chest is shown in Figure 64. Many builders have made modifications and changes in this windchest, though retaining its general principles.

Air is admitted individually to each set of pipes by means of a

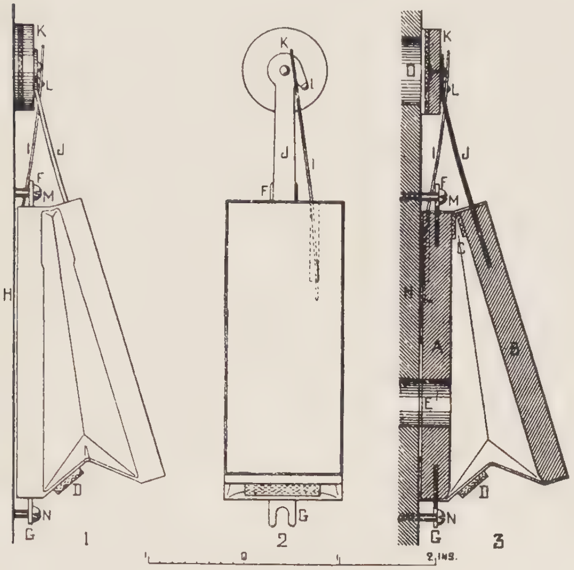


Figure 65.
Side, top, and sectional views of a Roosevelt pneumatic.

ventil, or stop action valve at one end of the windchest. This is shown clearly in Figure 66 and its operation is also described there. From this form of stop action is derived the general name for all windchests using ventils by means of which air may enter or be cut off from the pipe valve chambers. It is not necessary that individual pipe valve pneumatics be employed with a ventil windchest. For example the one built by Hillgreen, Lane and Company later described, is in reality an adaptation and improvement of an earlier form of windchest used in Germany, where one pneumatic is caused to operate a series of pipe valves.

The individual pipe valve pneumatic used by Roosevelt is shown in Figure 65. The operation of this windchest, referring to Figure 64 is as follows:

When the pneumatic attached to the tube leading to the key action is exhausted, the double valve, connected to a channel in the bottom board of the windchest, is drawn to the left, opening the channel to the atmosphere and shutting off further wind from the primary box. When the wind is exhausted from the channel in this manner, all the pipe pneumatics that connect with this channel are exhausted simultaneously. If the ventil allowing wind into the partition under a set of pipes is open, the pressure of this wind on the pipe valve pneumatics will cause

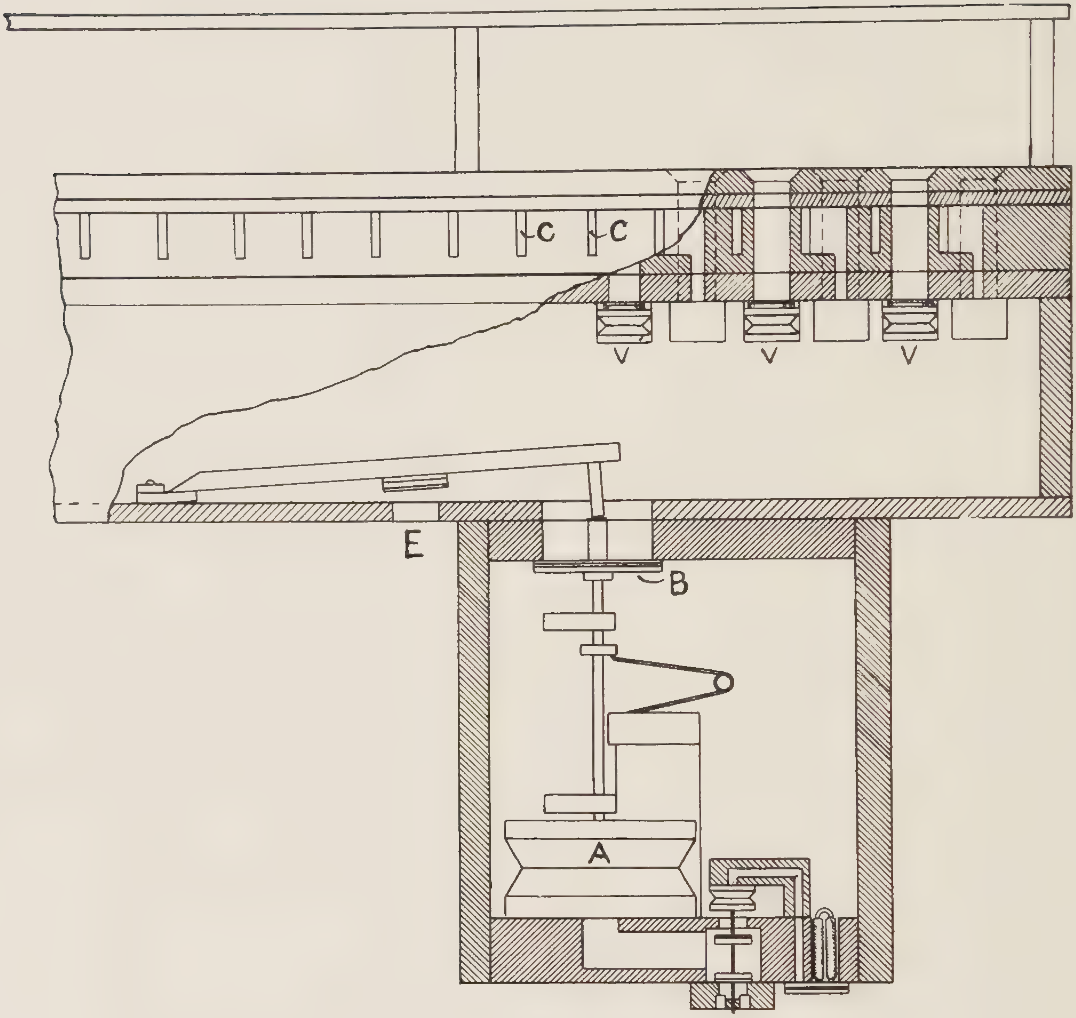


Figure 66.

Section through the front of an Estey Windchest. The pipe valves are shown at V, the channels into which the pipe valves exhaust are shown at C. The ventil stop action is clearly shown in this drawing. All builders using the ventil stop action use somewhat similar method of admitting air to the various sections of the windchest. Compressed air is present at all times, when the blower is running in the box under the windchest. Upon the magnet operating the primary valve being energized by the stop action, the power pneumatic, A, is exhausted drawing with it the large disc valve or ventil, B, which permits a large quantity of air to enter the pipe valve chamber. The stop is then in playing condition. It is shown in the above drawing in the closed or off position. It should also be noted, that when the ventil is in the off position it raises an exhaust valve, E, which allows all the air in the pipe chamber to escape instantly and thus silence the stop as soon as the stop action is shut off. This valve also permits any small leakage of the pipe pneumatics to find its way to the atmosphere, without gradually filling the pipe chamber with compressed air that might cause the pipes to sound, even though the ventil was not open.

them to collapse and allow air to flow into the pipes. If, however, no ventils are open to allow air to pass into any of the air compartments under the pipes, the pipe valve pneumatics will all remain stationary as there is no pressure of air against them to cause them to collapse and the spring holds them closed.

When the double acting valve on the primary is returned to the right (or the position shown in Figure 64), air from the primary box flows through the channel back into each pipe valve pneumatic, so that there is equal pressure on both sides, if the stops are on. The pipe valves are then held closed by their springs. If the stops are not on, wind pressure is only being exerted on the inside of the pneumatics, as the pipe chambers are open to the atmosphere. If the pneumatics become damp, there is danger of the leather blowing off them in this case, and leakage ensue. I have found by actual experience with this type of chest that this is more than a possibility in damp locations and is a serious disadvantage. In none of the other forms of windchests we shall describe, is there a tendency for the leather to blow off the pneumatics when the stops are not drawn.

An interesting point to observe in connection with the operation of the Roosevelt and many other modern windchests is that it is only necessary to displace the amount of air contained in the pipe valve pneumatics through the channel in the bottom board to cause them to collapse. Conversely, only sufficient air need be replaced in the channels to refill the pneumatics. Therefore, the action in reality takes place more rapidly than would be possible if the pneumatics did not collapse until all the air was exhausted from both the pneumatics and the channel; or on the return motion, both the channels and pneumatics had to be refilled, before the pneumatics would close. This same principle holds true fortunately, for all pipe valve pneumatics and the speed of the action is thereby greatly increased. The channels referred to here and in our discussion of the various forms of pitman windchests are in reality a series of air channels or grooves either in the bottom board or top board of the windchest that connect directly with all the pipe valve pneumatics that are playable from a single note on the keyboard. If there are twelve stops playable from one manual key, there will be twelve pipe valve pneumatics that are controlled by this channel through the primary valves. The key action merely operates the primary valves either pneumatically or electrically, which in turn permits the wind to exhaust from or reenter the channels.

Figure 69 shows the bottom boards with the veneer removed. The grooves, together with the holes bored into them corresponding with the pipe valve pneumatic holes are clearly depicted.

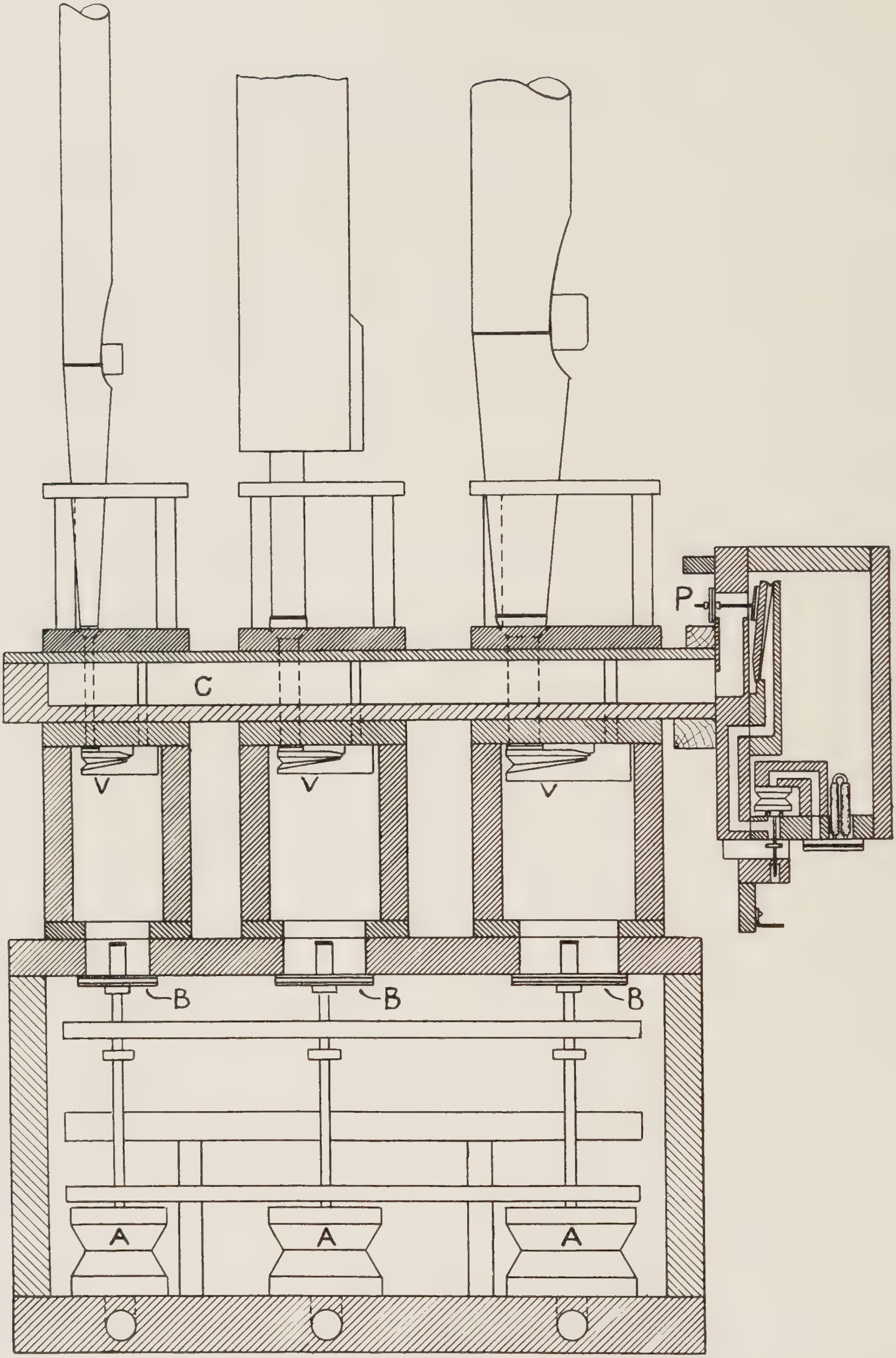


Figure 67.
Section through the Ventil Windchest made by the Estey Organ Co.

In the Estey windchest shown in Figures 66 and 67, it will be seen that the action is a modified form of the Roosevelt windchest with the channels in the top board. The individual pipe valve pneumatics are made with the pipe valves attached to the pneumatics instead of being attached to a lever actuated by the pneumatics as in the original Roosevelt example. Such differences are not important in describing general principles, though the Eastey form is undoubtedly an improvement on the original, and gives a greater speed to the action.

The Kilgen Company employ a ventil windchest wih a very different form of pipe valve pneumatic. The same form of action is used also by the Wangerin Organ Company of Milwaukee. Figure 70 shows the Kilgen adaptation of the ventil windchest. The stop action is the same as in other examples already described. Instead of a pipe valve pneumatic

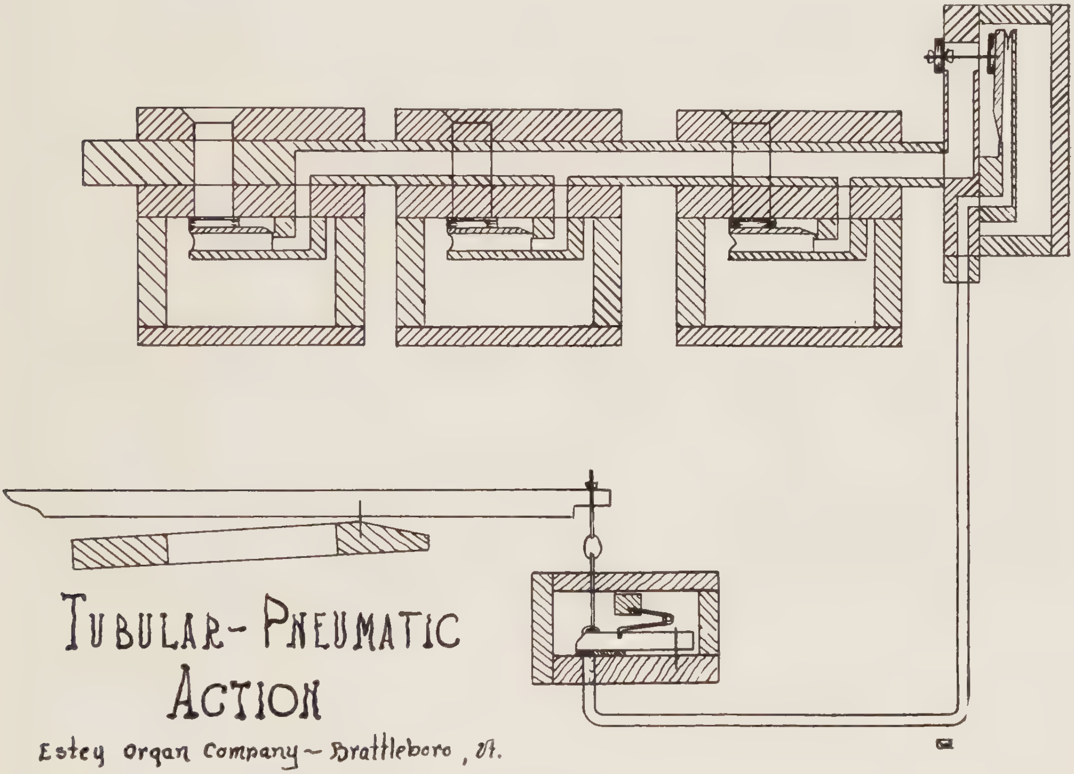


Figure 68.

Sectional view of the individual pneumatic windchest with the pipe pneumatic exhausted by tubes, which in turn are exhausted by valves operated mechanically by the keys themselves. This is a later form of the tubular pneumatic action than that shown in Figure 50, and still employed by the Estey Organ Company in small organs.

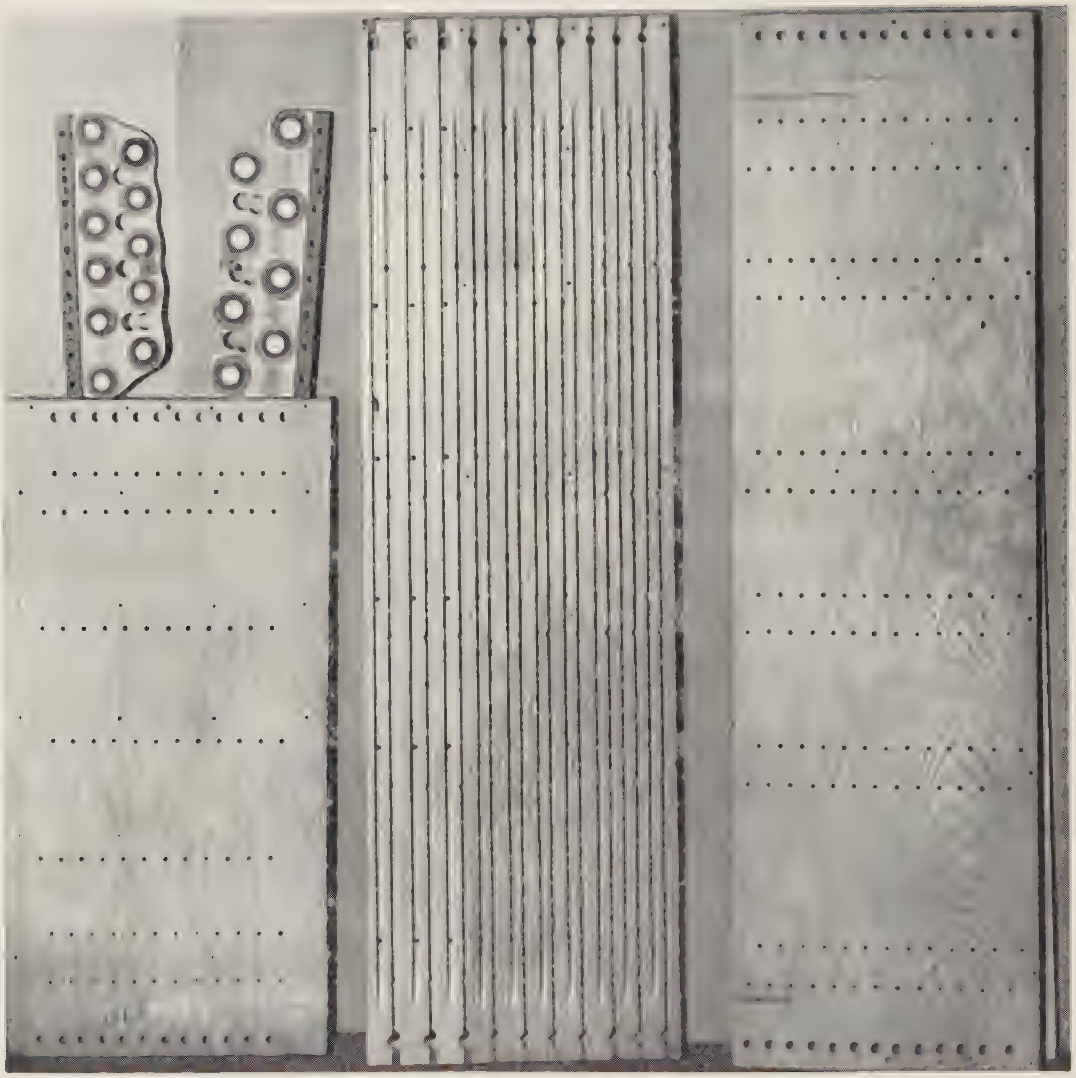


Figure 69.

A photograph showing details of the bottom boards of a Moller windchest. The bottom boards have their channels cut on a special saw, and then a thin piece is glued on enclosing the channels in the central portion of the bottom board. At the right, the top side of the bottom board is shown, with the holes bored corresponding to the holes in the stop action bars shown in Figure 80. The bottom boards are packed with leather where they are joined with the main portion of the windchest, and securely screwed thereto, so that they fit air-tight. In the upper left is shown the pouch boards, which are made in short sections, permitting of easy removal, by taking down only one bottom board. The pouches are more clearly shown in our sectional drawings.

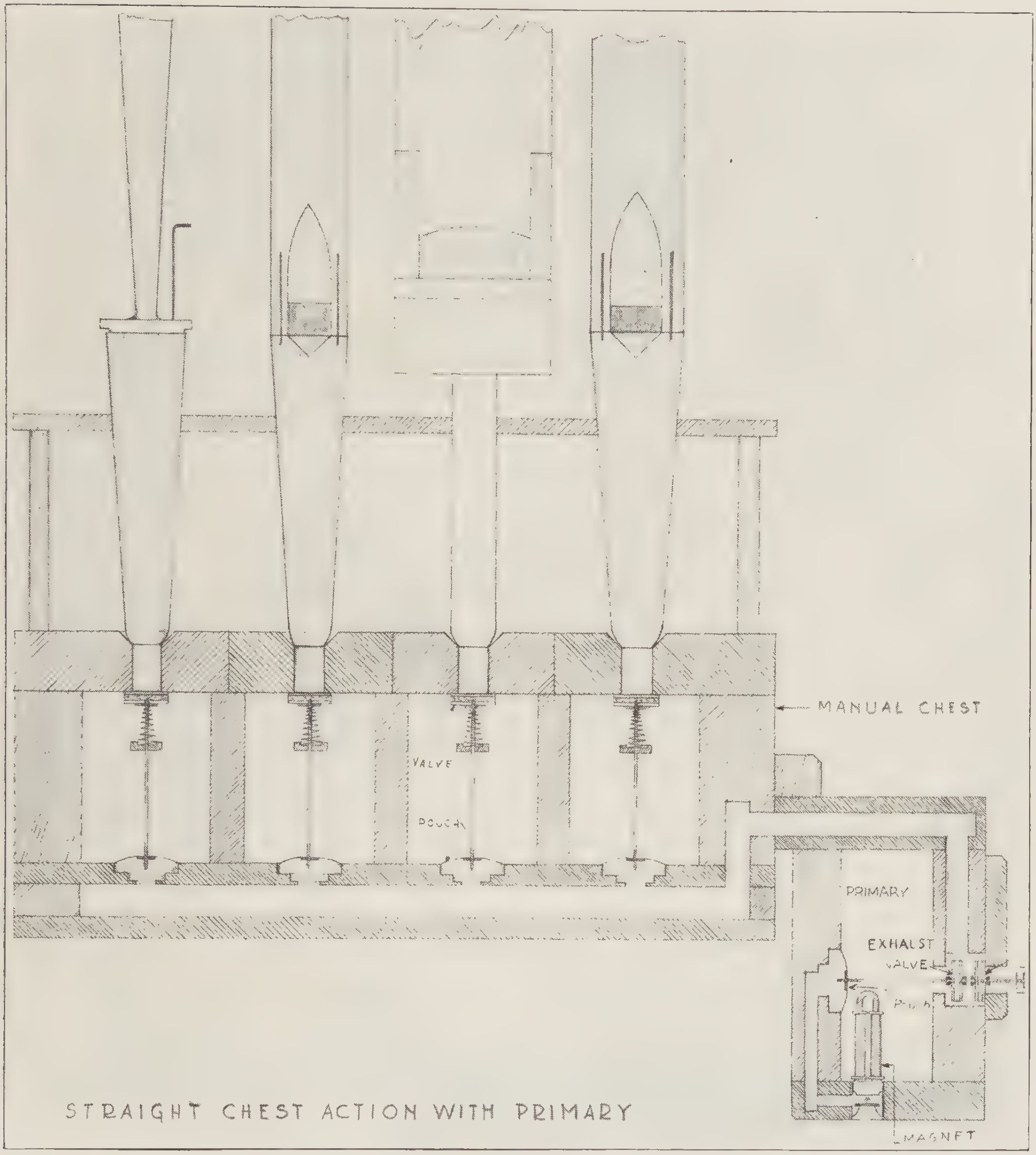


Figure 70.

The pipe valve assembly used by Geo. Kilgen & Sons of St. Louis consists of fibre discs on which are glued felt and leather. A tapped wire controls the motion of the disc valve by connecting it to the pouch located in the bottom board of the windchest. The pouches are exhausted directly into the channels in the bottom board. This style of windchest requires much less boring of holes than any form of the pitman windchest.

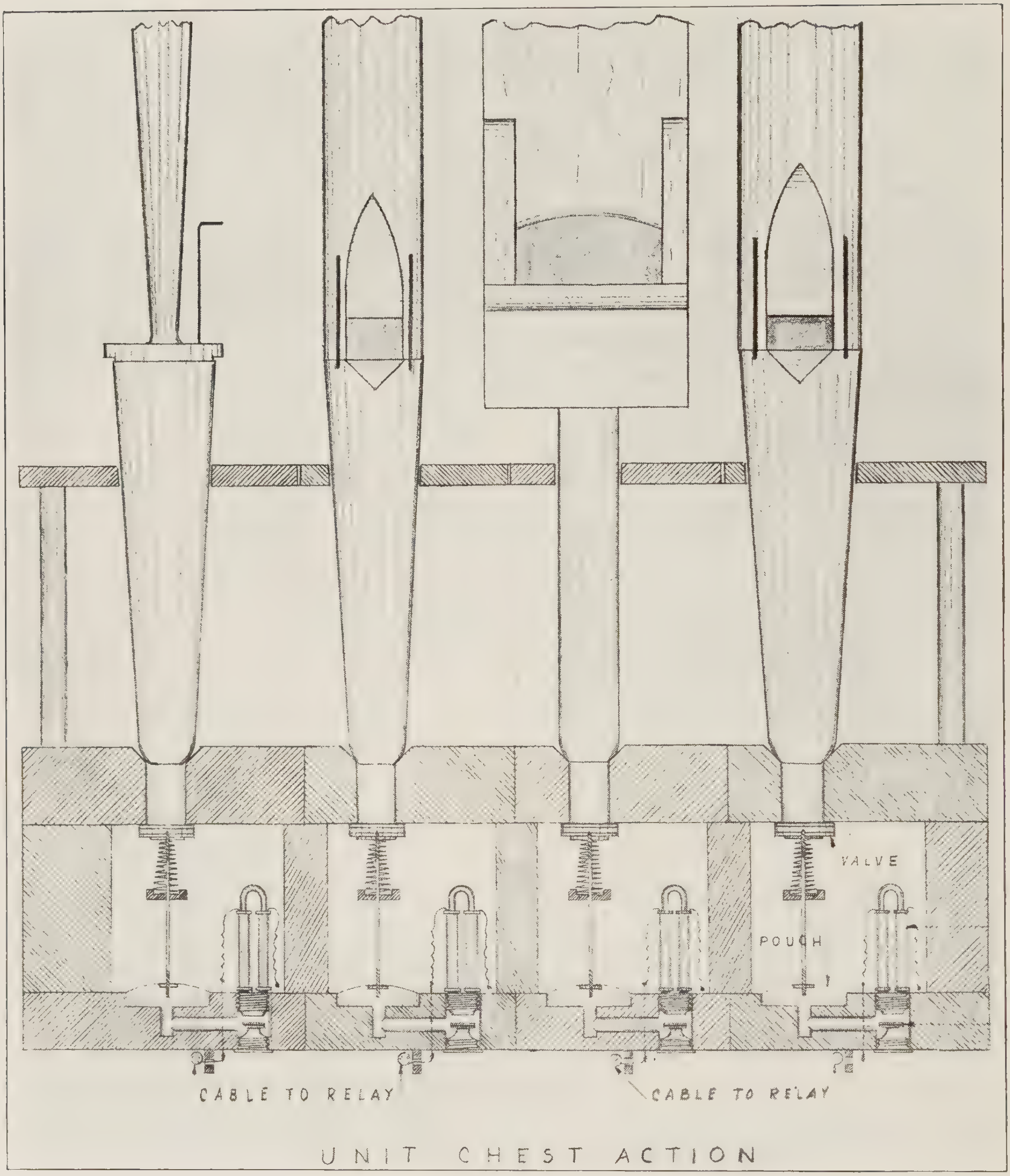


Figure 71.

A section through a unit windchest, where each pipe has its own magnet, permitting it to be played in any manner it is desired, by means of a series of switches, which allow the magnet circuit to be closed. Geo. Kilgen & Sons, Builders.

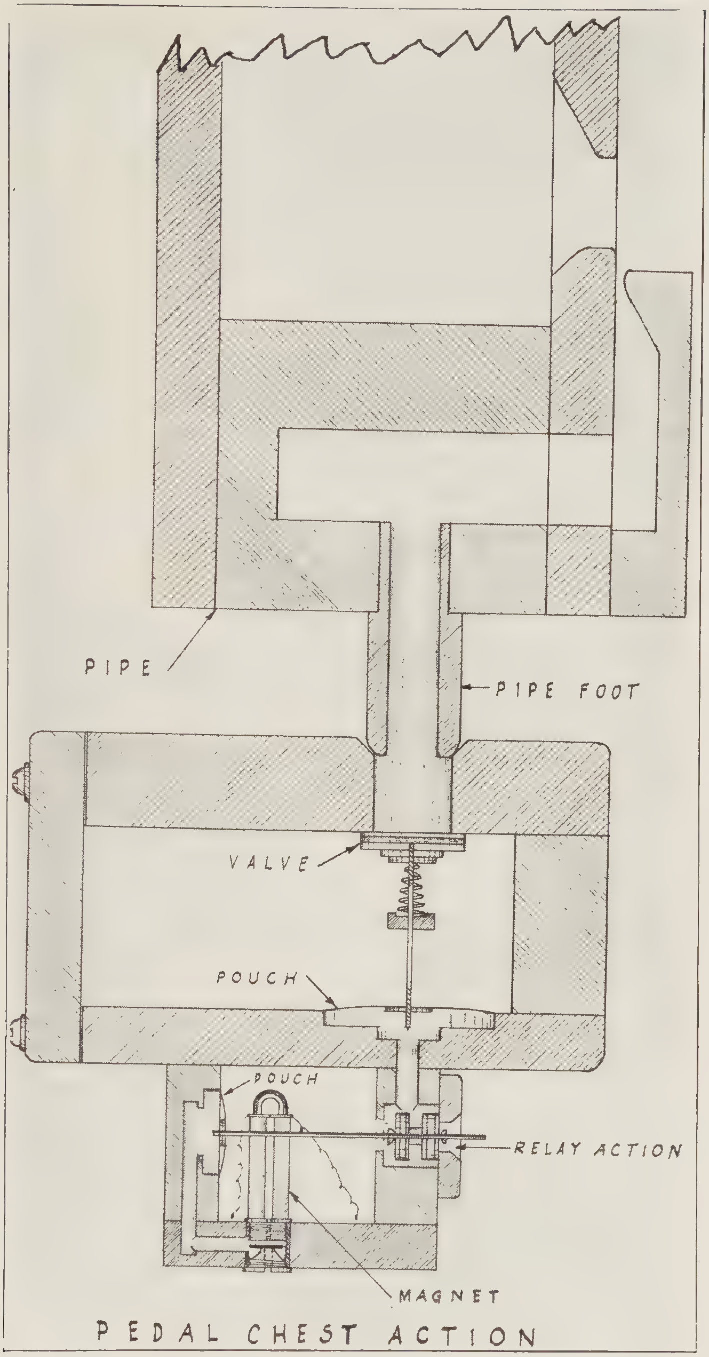


Figure 72.

George Kilgen & Sons, Builders. A section through a pedal windchest. In this case the magnet does not exhaust the pipe valve pouch, directly, as the pouch is too large for drawing down the pipe valves for the larger pedal pipes to be exhausted quickly through the small hole in the magnet. An additional valve mechanism is interposed, similar to that used in the primary valves of the straight windchest action. The magnet in this case has merely to exhaust the air from the smaller pouch which in turn exhausts the air from the larger pipe pouch by opening the double acting valve, labeled "Relay action" in the above drawing.

being used with folding leather sides and partly made of wood, like a small bellows, a pouch or diaphragm is used.

The pouch form of pneumatic is quite old and was probably first used by Walcker in Germany, at least the oldest examples of the diaphragm or pouch pneumatic may be found there.

It has since come to be very largely used by American builders, Casavant being the first, so far as I can determine, to employ the pouch pneumatic in America. In the Kilgen action the pouches are mounted directly onto the bottom boards, and thus may be exhausted directly into the channels. A large amount of boring of holes necessary in other forms of windchests, where the pipe valve pneumatics are placed directly under the pipe holes, is thereby eliminated. A tapped wire connects the pipe valves with the pouches. The wire being secured in the pouch leather by means of a leather nut. These valve wires run through guides, that also serve to support the coil springs that hold the pipe valves closed when the pouches are not being exhausted of air.

When it is necessary to make repairs or adjustments in the Kilgen windchest, a bottom board is removed, which has attached to it all the pouches and pipe valves for that section of the windchest. Such an action has a good deal to commend it, and when carefully made should give very little trouble. There is sufficient "play" allowed in the valve stems to compensate for swelling or shrinking in the wood of the windchest, and the mechanism will not become deranged from this cause.

All windchest mechanisms, to be really successful, must necessarily make allowances and have means of compensation for atmospheric changes. Hair trigger and fine adjustments beyond a certain point must prove impractical, as they are too sensitive to swelling and shrinking. A certain margin of safety should be allowed in the design of any successful organ action, to permit the wood portions of the windchest to come and go, without readjustment of the mechanism being required.

The reliability and freedom from trouble of the majority of modern actions has been accomplished for the most part by having the above features in mind when the actions were designed.

WINDCHESTS WITH SOME FORM OF THE PITMAN STOP ACTION

We come now to the description of the windchest that is more generally employed than any other by present day American builders. Mr. Ernest M. Skinner says that he is the inventor of the pitman windchest. The term pitman I find by reference to the International Dictionary means merely a connecting rod. It was applied to sewing machine pedal connecting rods. The pitman valves in an organ windchest take the

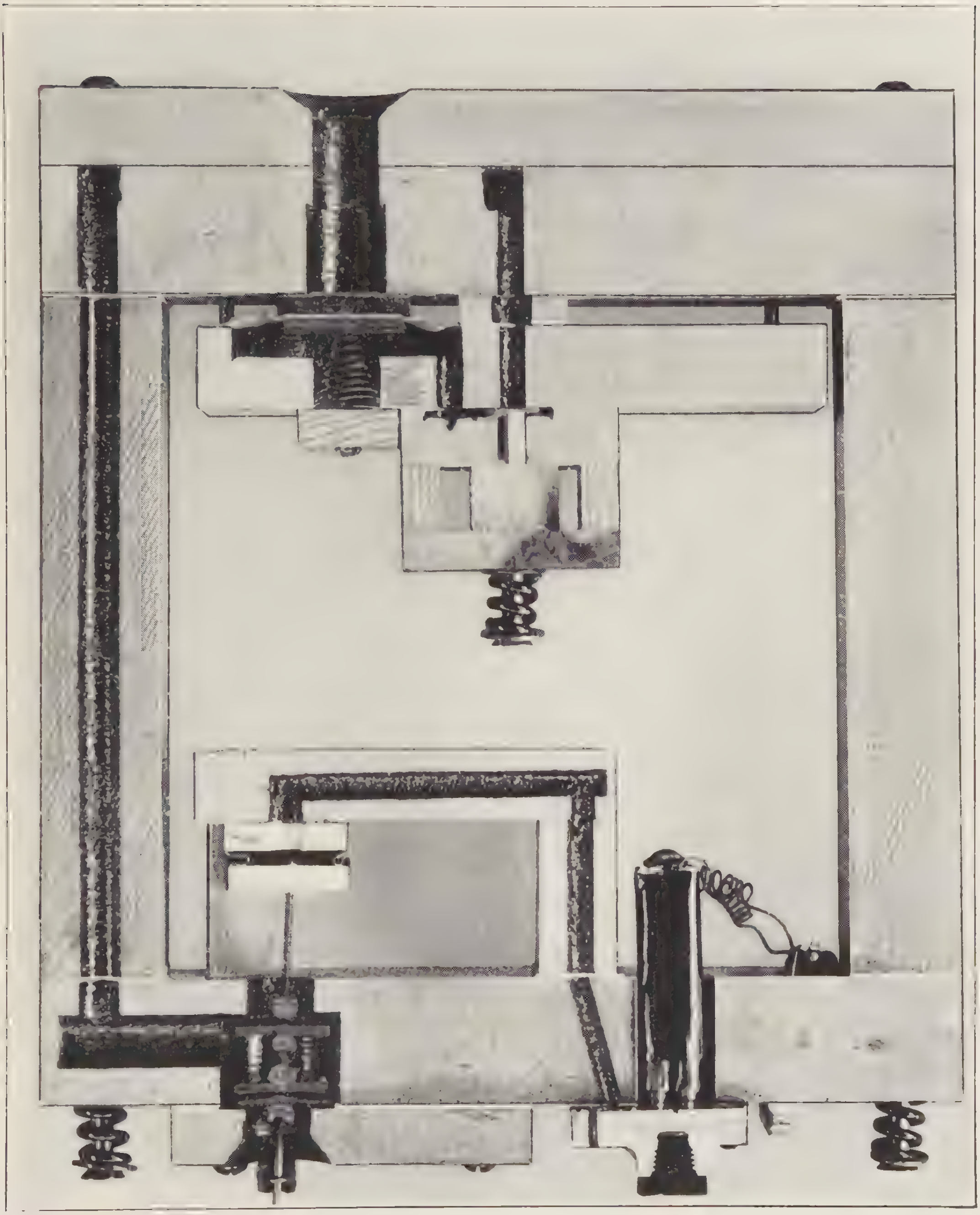


Figure 73.
A photograph of a section of the Kimball windchest.

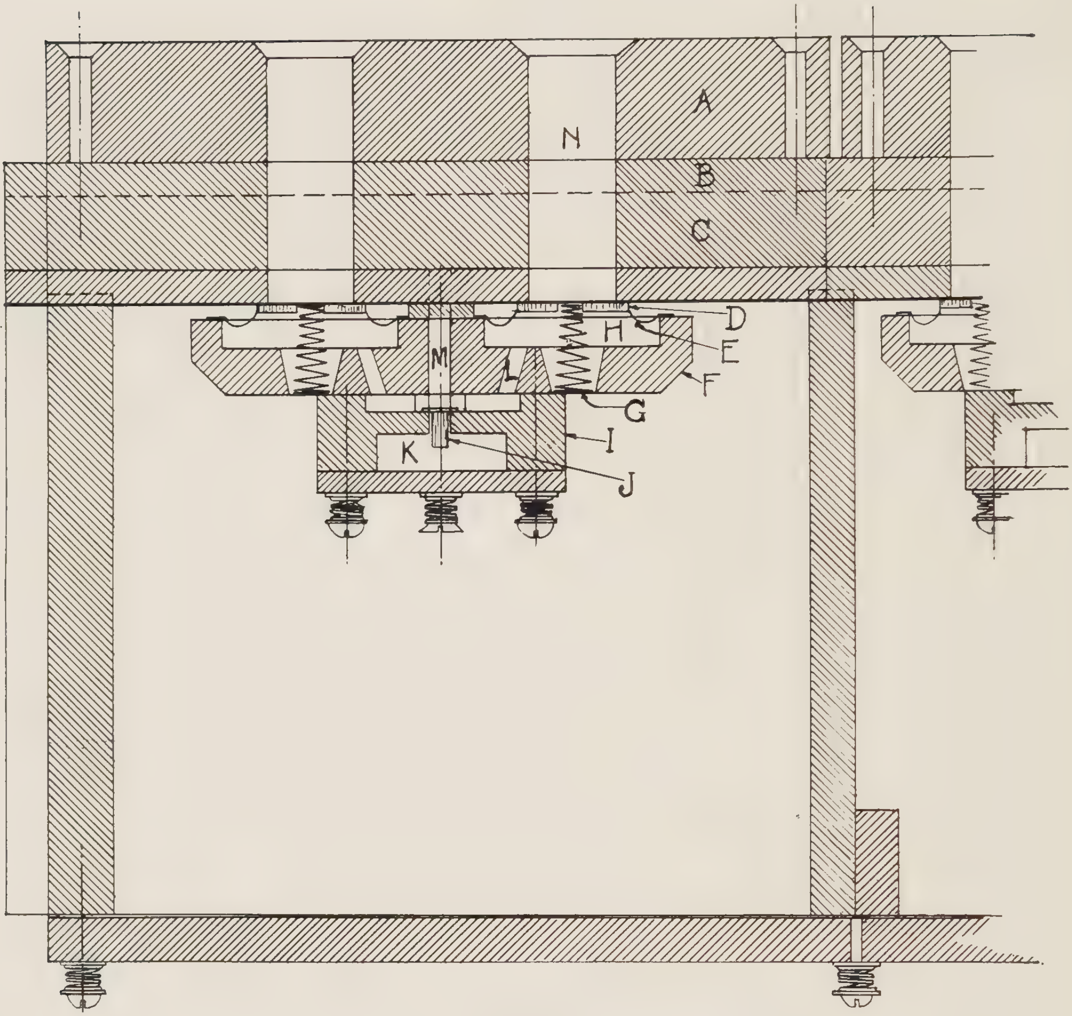


Figure 74.

A section through the Straight manual windchest manufactured by the Skinner Organ Company. This is known as the pitman windchest, and is described in the text. The primary valve mechanism that exhausts the channel, C, is not shown in the drawing, but this mechanism is similar to that shown in other drawings of the pitman action, except that the Skinner Company employ two valves to exhaust the channels, a primary and secondary valve. It is considered that the two valves increase the speed of the action. Other builders secure satisfactory results with one primary valve.

place of ventils in controlling the stop action. It must be clearly understood at the outset, in examining any of the drawings of the various forms of pitman windchests, here presented, that the wind pressure is beneath the pipe valve pnuematics at all times when the blower is running. With all ventil windchests such pressure is in the pipe valve chambers only when a ventil is open. The pitman windchest is sometimes called a universal windchest for this reason. The pipe valve pneumatics are permitted to exhaust or remain closed in accordance with the action of the pitman valves which will be later described.

In a letter I have received from Mr. Skinner, he makes the following statements:

"I see the frequent mention of the pitman, which is sometimes spelled with a capital 'P'. In Senator Richards' Atlantic City specification, he speaks of the pitman windchest and follows with a mention of Austin's 'Universal windchest', but he does not give me the same credit that he gives Austin. The pitman windchest is the invention of your humble servant and was published for the first time in Audsley's 'Art of Organ Building', page 347, volume 2. I made this drawing for Audsley but he did not give me credit for it. This chest bids fair to become universally used, but the unfortunate inventor is lost sight of. I think I will have to write up the pitman windchest and take the credit that belongs to me before I lose it for good.

"This drawing that I made for Audsley also shows the use of a high pressure arrangement which can be located anywhere in the chest. It also shows, for the first time, an arrangement for playing a stop from two manuals which was discarded many years ago, in view of the single pipe valve and an arrangement for operating it from two sources. This pitman device arrangement is now about 35 years old, or as old as the pitman windchest itself.

"Mr. Richards stipulates that only eight stops shall be placed on any one chest showing that he, along with the balance of those interested in this chest, does not know that the pipe pneumatic is not exhausted through the key channel, but on the contrary, exhausts into the stop action channel when rush of air in the key channel sucks the pitman over to the key port leaving the channel open for the pipe pneumatic to exhaust directly underneath said pipe pneumatic and out the stop action. This exhaust of the key channel not only reaches atmo-

---

NOTE: I have avoided, as far as possible, making direct statements concerning some original inventions in organ building. So many builders have worked on the same problems at about the same time that it is frequently difficult to be absolutelv sure as to who was first in many matters. To avoid controversy that might otherwise arise, I have quoted the builders themselves or other authority when I have good reason to believe their statements are correct.

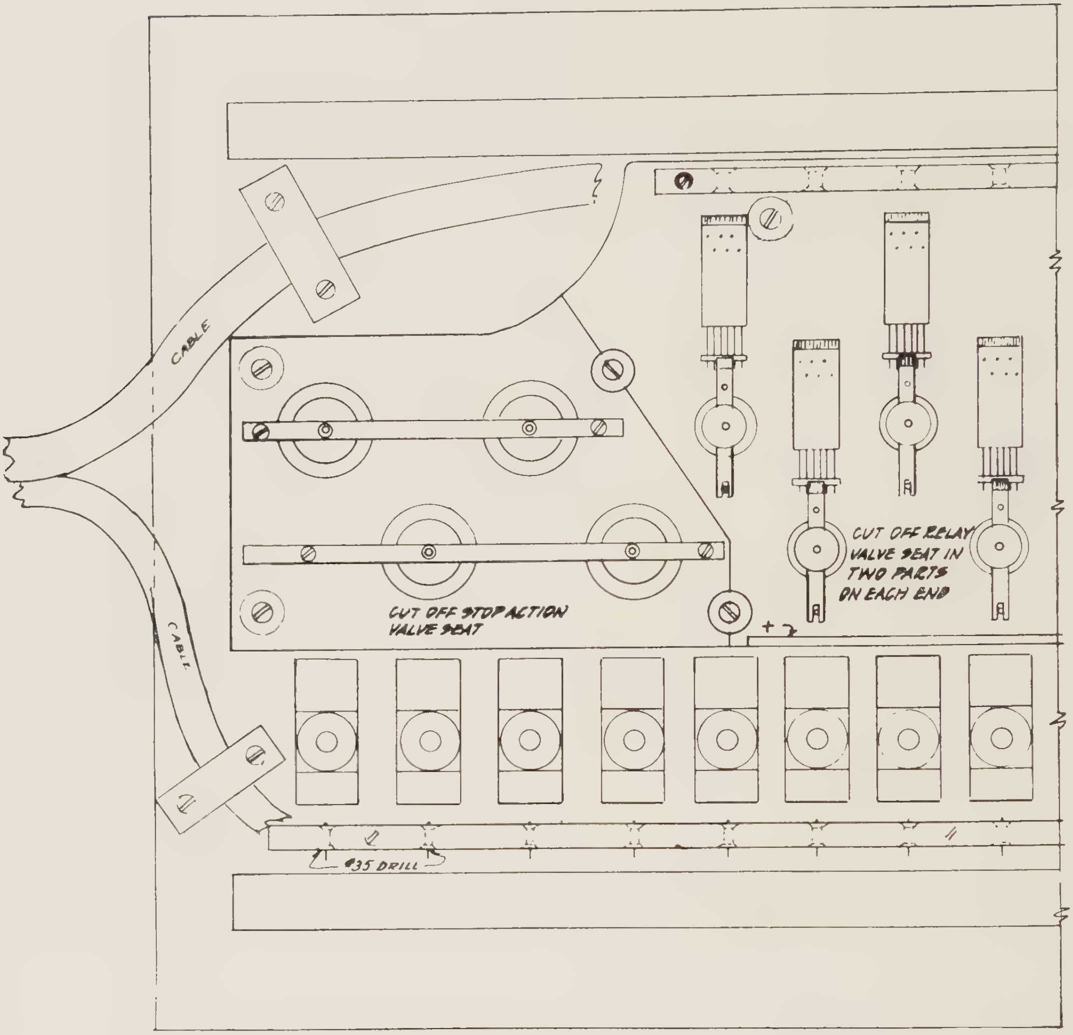

CABLE
CABLE
CUT OFF STOP ACTION VALVE SEAT
CUT OFF RELAY VALVE SEAT IN TWO PARTS ON EACH END
#35 DRILL

Figure 75.

A view from the bottom of the primary shown in Figure 76. This view shows the arms attached to the primary valve stems that make contact with the contact blocks, when the valve stems move. This is a very ingenious method of operating a relay mechanism, where additional contacts are required, without the use of additional pouches and other mechanism. The contacts are bound to be made as rapidly as the primary valves can be made to operate.

sphere in rushing out the key primary, but develops a very positive suction owing to the inertia of the air, which still further serves to suck the pitman over towards the key exhaust.

"I suppose musically, as far as the mechanism goes, that the instantaneous stop action incident to the pitman chest should be regarded as extremely valuable on account of the orchestral precision that it makes possible in registration."

Mr. Skinner also states that he is the inventor of the closed circuit stop action and states the following:

"The closed circuit stop action eliminated one contact on each register and one magnet at the stop. There used to be an on and off contact and an on and off magnet. I believe I was the first to use a high resistance closed circuit stop action, and made the modern Crescendo and Sforzando possible. At all events nobody else ever used it until I did, and now they are all using it. I don't believe there is one out of the lot who knows who started it."

We shall first describe the pitman windchest in the form used by the Skinner Organ Company. Figure 74 is a cross section through a portion of such a windchest. The pitman valve is shown as J. It consists of a small piece of hard wood with square sides about ½″ long and ⅛″ on each side, on one end of which is securely tacked and glued a disc about ½″ in diameter of suitable leather. The pitmans are well black leaded and all edges are smoothed to avoid the possibility of sticking in the hole in which they work back and forth.

Each pipe valve pneumatic shown at H has a corresponding pitman valve. The pitman valves are placed in a box K which runs longitudinally throughout the length of the windchest. The box K may have wind admitted to it or it may remain open to the atmosphere. The stop action valve controls the entrance of wind to the pitman box or opens the box to the atmosphere.

When wind is present in the box K, the pitman valve J remains in position shown in Figure 74, providing no key is depressed and air is present in the channel C. This is true, because there is equal pressure on each side of the pitman valve and gravity holds it down. Upon the channel C being exhausted by the key action primary, the air cannot escape from the pouch H as the pitman immediately blows upwards covering the port M leading into the channel C. In reality the pitman valves remain stationary when the stops are on and also when the stops are off, except when a key is depressed in which case the pitman valve affected by the key action will blow upward as explained above and cut off the egress of wind from the pouch, thereby preventing the pouch acting and the note sounding.

When the box K is exhausted of air, the pitman valves remain as shown in the drawing and prevent the escape of air from the pouches that flows to them through the port M and the channel C from the key action primary box. When the channel C is now exhausted the pouch H will collapse as the pressure of the air on the outside of the pouch is no longer balanced by similar pressure on the interior. The pouch exhausts through M and L and C into the atmosphere. This is the majority opinion of the manner of operation of the pitman windchest. The inventor holds a different view which we have already quoted above. Here is a case where authorities disagree, and perhaps it is not of so much importance, how it works, as the fact that it does work and with the greatest possible speed.

It should be noted that in this windchest the channeling is all done

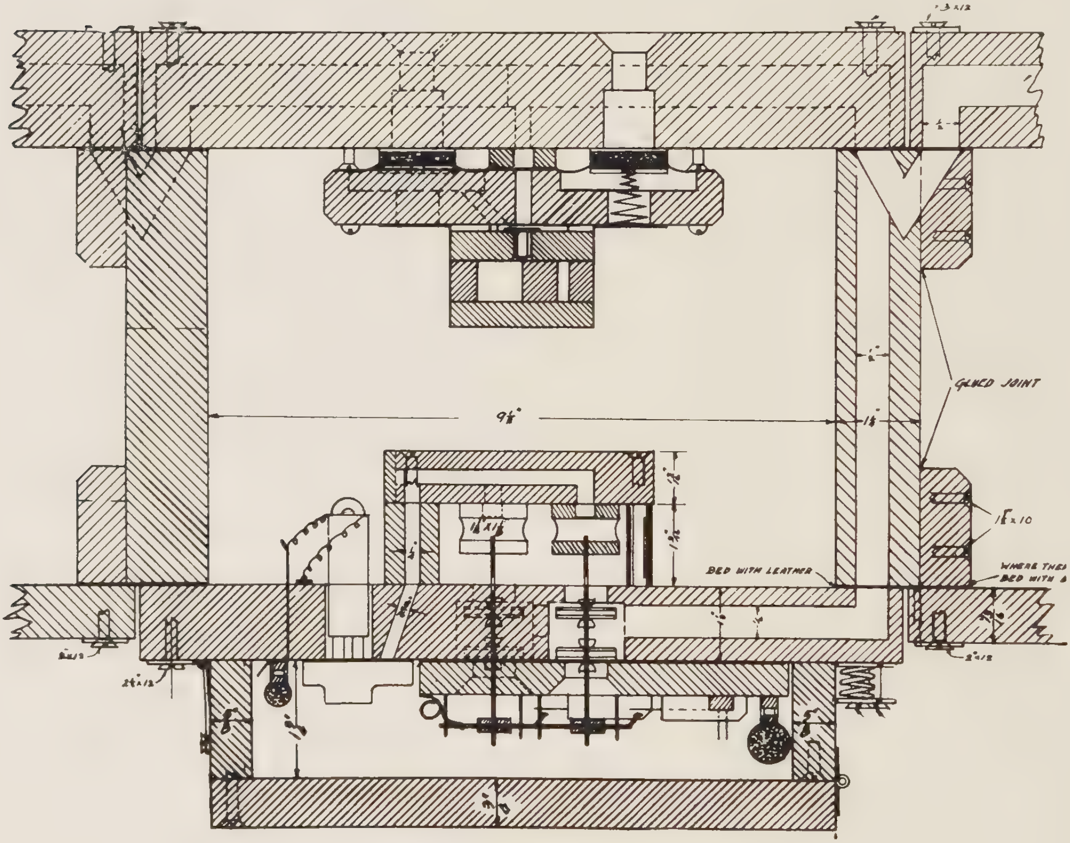


Figure 76.

A section through the pitman windchest manufactured by the W. W. Kimball Company. The primary valve stem has a relay mechanism attached to it, shown more clearly in Figure 75.

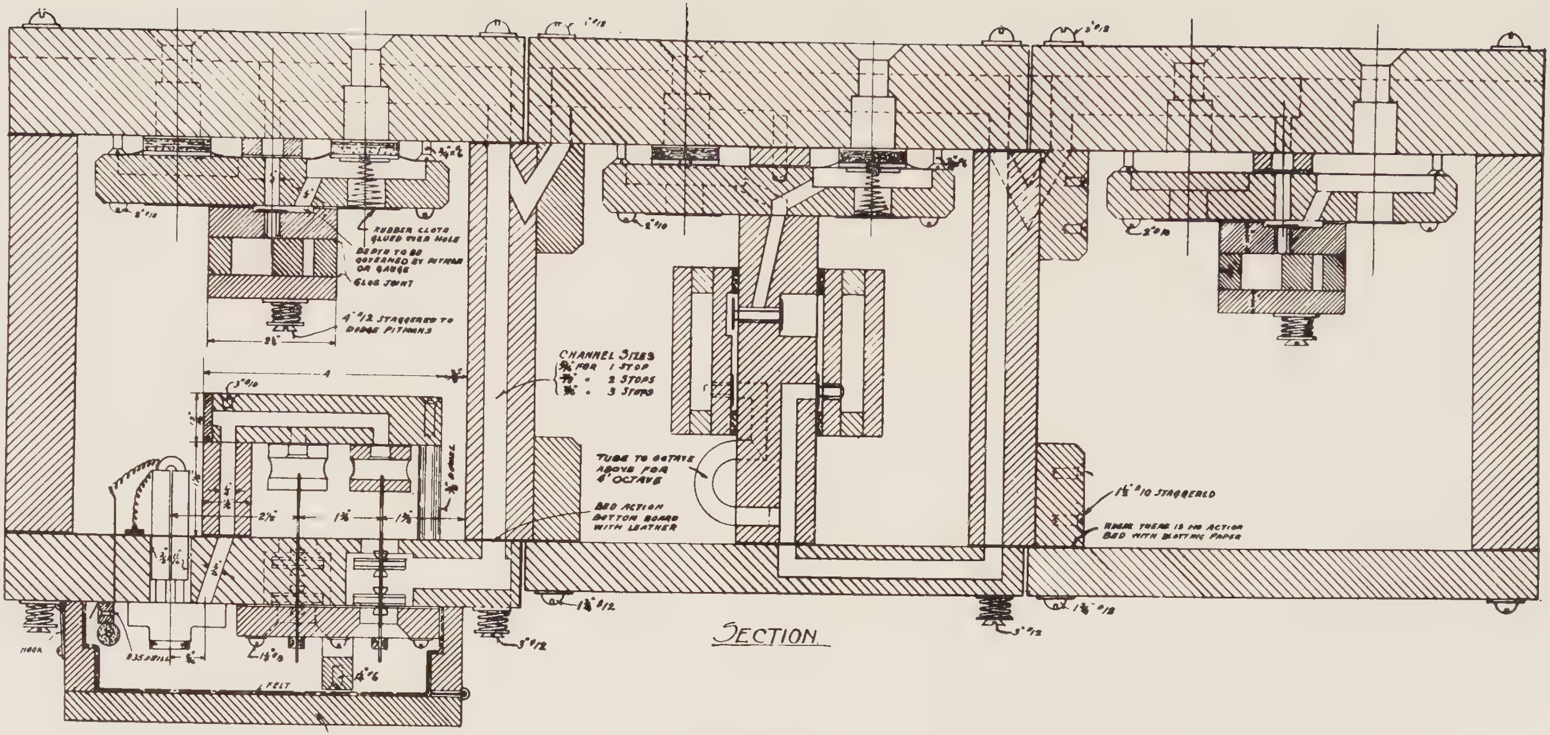

RUBBER CLOTH GLUED OVER HOLE
DEPTH TO BE GOVERNED BY PITMAN OR GAUGE
GLUE JOINT
4" #12 STAGGERED TO DODGE PITMANS
CHANNEL SIZES
FOR 1 STOP
" 2 STOPS
" 3 STOPS
TUBE TO OCTAVE ABOVE FOR 4' OCTAVE
BED ACTION BOTTOM BOARD WITH LEATHER
1½" #10 STAGGERED
WHERE THERE IS NO ACTION BED WITH BLOTTING PAPER
FELT
HOOK
SECTION

Figure 77.

A section through a three stop Kimball windchest. This shows the manner in which the channels are run in the top board of the windchest, by cutting V shaped grooves in the sections of the windchest to which the top and bottom boards are screwed. This permits of channeling the top boards without making them all in one piece as is done in the windchests made by the Skinner Company and the Aeolian Company. The center section of the drawing shows the "Duplex" action, whose operation by means of a shifter is similar to that which has been described in detail for the Moller "Duplex" action. The same duplex action in all essentials is employed by the other builders of the pitman windchest.

in the top board. The channels obviously must run on either one side or other of the pipe holes N as they cannot run into the pipe holes. The top of the windchest is in reality double—the top board A on which the pipes stand and the channel board BCD. This latter board is made in a single wide piece glued up, and is subject to a large degree of swelling and shrinking, particularly if the windchest is a wide one. The lumber used for the ends of the windchest has the grain running in the same direction as the top board so that the whole windchest may swell and shrink without causing any undue strain on its parts. To facilitate the "come" and "go" of the lumber, rollers are placed under the chest but scarcely seem necessary for when the top board starts to swell, many tons pressure cannot prevent its movement. Forces set up in lumber by moisture that cause expansion are of enormous power, and expansion or contraction cannot be prevented by any known means. In this windchest no effort has been made to prevent swelling and shrinking. Careful designing allows this to take place without injury to the windchest itself or to the satisfactory performance of the action.

The Aeolian Company employ a windchest so similar in principle and construction, including the method of channeling through the top boards to that of the Skinner Company, that there is little more to be said about it, except that their latest examples function with great speed and reliability, the two most desirable qualities for a windchest to have.

The Kimball windchest of which we show several drawings and photographs, operates also in a manner similar to the Skinner example. Its operation may be clearly understood from an examination of the various drawings and by referring to the description given for the Skinner example.

A special feature of the Kimball windchest is the counter-boring immediately above the pipe valves. It is contended that the additional flush of wind permitted by the enlargement of the pipe holes at this point assists in obtaining more prompt speech or attack from the pipes. Also, though the channels in the Kimball windchest are in the top board, they do not run continuously through the top board, as this part is divided into separate boards, the width of each stop.

The channels run down into the dividing rails with V shaped cuts as shown in Figure 77. Such construction allows the top of the windchest to shrink or swell freely with no strains on any of the mechanism.

The Moller pitman windchest differs from the ones used by the three builders just mentioned principally because the channeling is done through the bottom boards. Also the form of pitman valve has been simplified. Instead of using the wooden tail piece with the leather disc valve tacked and glued onto it, the former is discarded, and a leather disc is all that is used. This disc seats against an eyelet and rests against a paper punching.

Referring to Figure 78, Z is the pitman; Y is the eyelet against which it blows, when AA, or the pitman box is open to the atmosphere, and the channel or groove is exhausted of wind. The action otherwise is similar to the Skinner windchest action already described.

The Duplex Action between two manuals is also shown in Figure 78. This consists of two complete sets of pitman stop action valves applied to one stop. By this means the stop may be drawn or shut off from either manual at will. The grooves in the bottom board must then be double for each note. One groove is exhausted by the Great organ primary; while the groove immediately adjacent is exhausted by the Swell organ primary valve, if the chest is duplexed (that is, has stops made interchangeable) between Great and Swell.

There are in this case, not only two complete stop actions for a single stop, but two grooves leading from the point where a "shifter" is located. T is the shifter. It is simply a pitman valve with leather discs tacked and glued on each end of a hardwood strip. The strip is sufficiently long to permit the shifter to move easily to the right or left. Now if the right hand pitman box AA be exhausted of air, pitman Z will blow up against Y when the groove is exhausted which connects with this pitman. The pipe valve pouch S will be exhausted at the same time through Q and the right duplex groove, as the shifter T blows to the right. If wind is in the left pitman box or the stop is off, wind will blow up through the left duplex groove and hold the shifter to the right. When both pitman boxes are exhausted to the atmosphere, the stop will play on either keyboard and the shifter T remains midway between.

This same principle is applied when a stop is duplexed an octave higher or lower on the same manual. In this case double grooves are not required in the bottom board. A series of tubes is merely run from the shifter box to the octave above or below. Two stop action pitman boxes are required with this duplexing as with ordinary duplexing, one for the unison pitch and one for the octave borrow. This is a very economical method of borrowing an 8′ stop an octave higher or lower, as the mechanism required is but a small fraction of that for a unit action.

Another form of windchest that contains a unique feature in regard to the stop action control is that used by Henry Pilcher's Sons of Louisville, Ky. It has neither the ventil nor pitman stop action, but a special valve placed in the pipe valve pneumatic itself.

From Mr. Paul B. Pilcher I have received a letter from which I quote certain sections that describe the operation of this stop action.

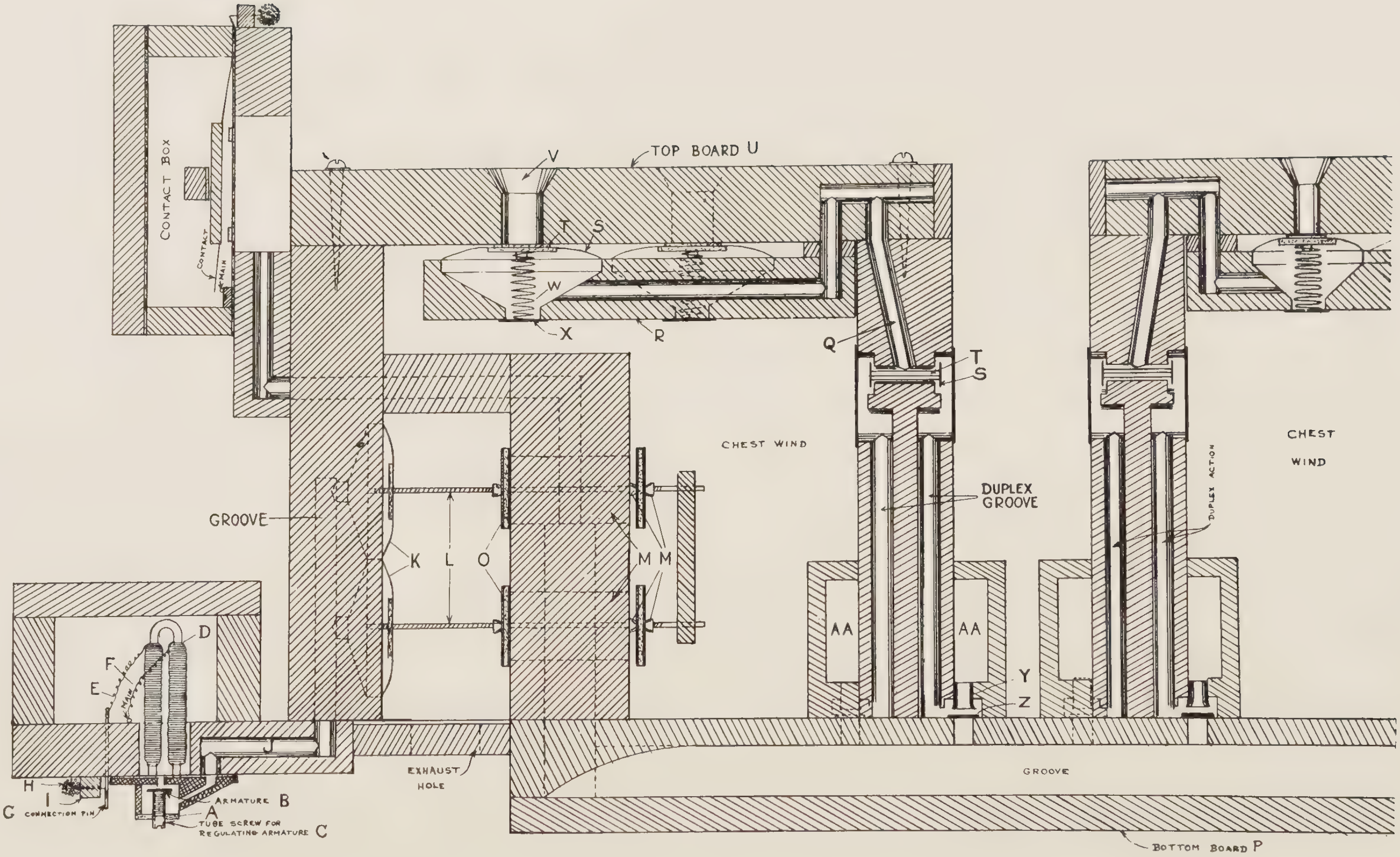


Figure 78.

A section through a Moller windchest showing the "Duplex" action. This drawing also shows the manner in which the contacts for a relay are attached directly to the windchest and are operated pneumatically by the primary action.

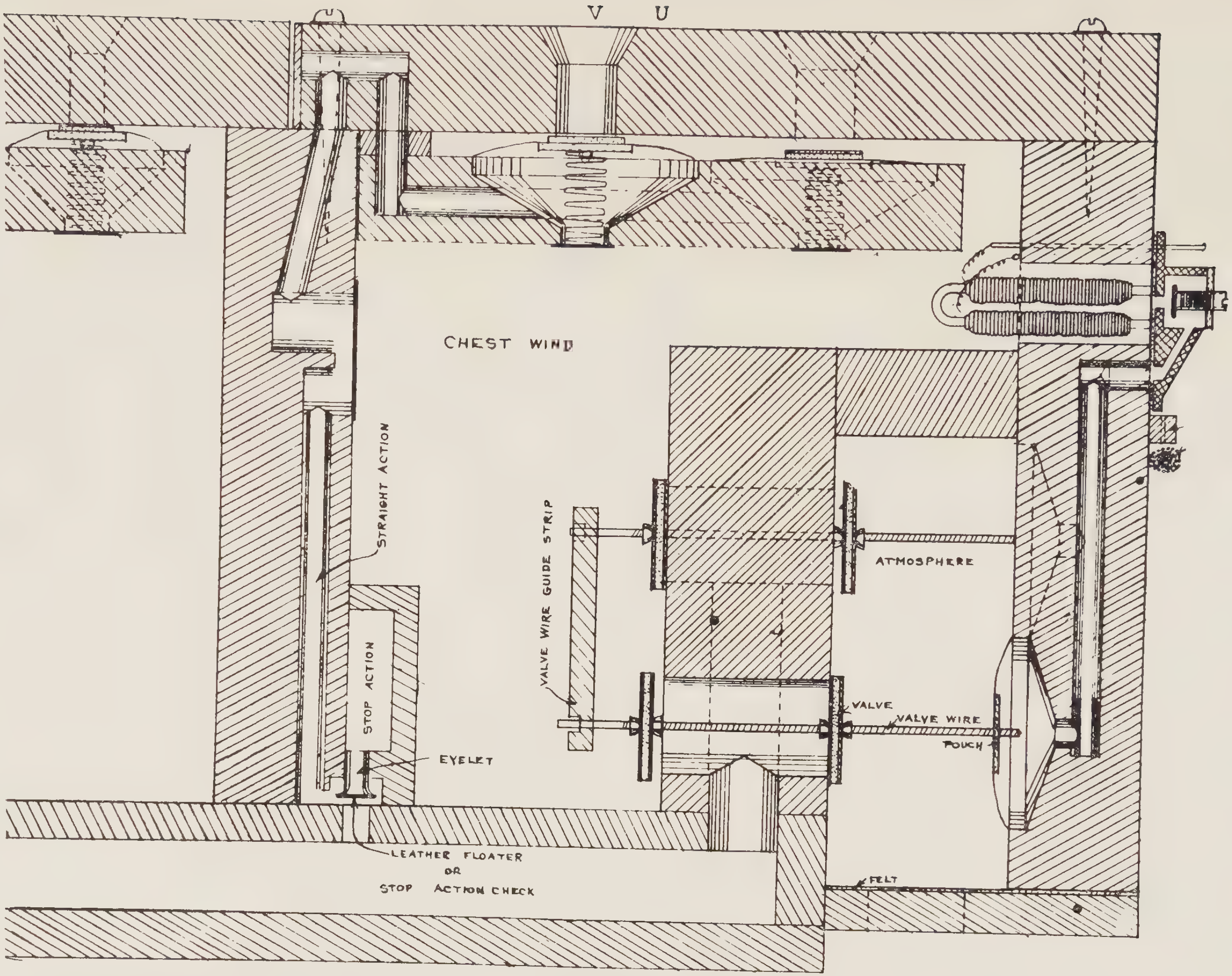


Figure 79.

A section through a straight Moller windchest. The primary is compactly placed inside the windchest itself, which has only one disadvantage: the top board, U, must be removed to get at the pouches for the one stop that is immediately above the primary mechanism.

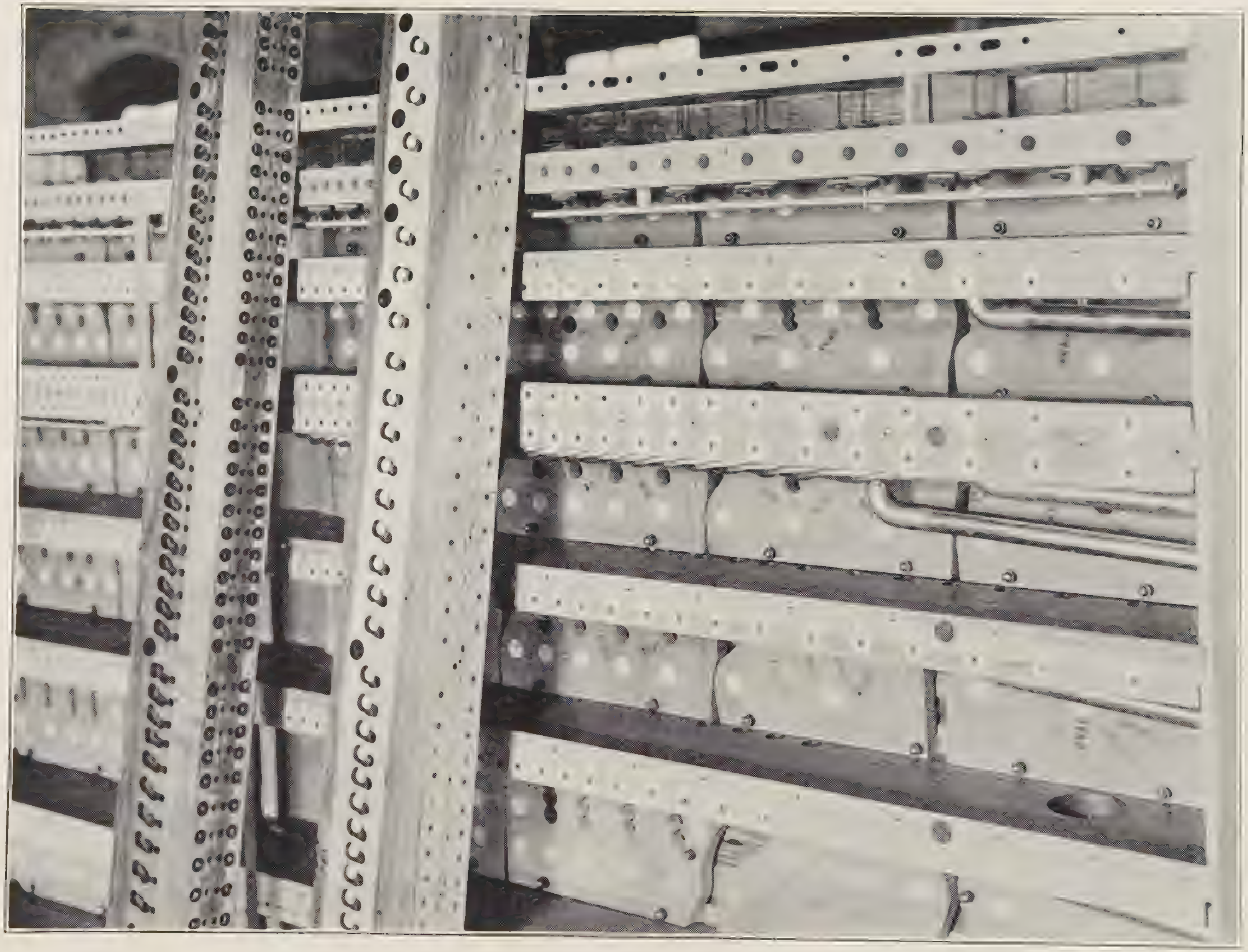


Figure 80.

A photograph of a Moller windchest with all the bottom boards removed. Small pieces of paper are glued under the stop action floaters to keep them from falling down, when the bottom boards are removed. The vertical bar standing at the left is a duplex action bar, before the shifters have been installed, an

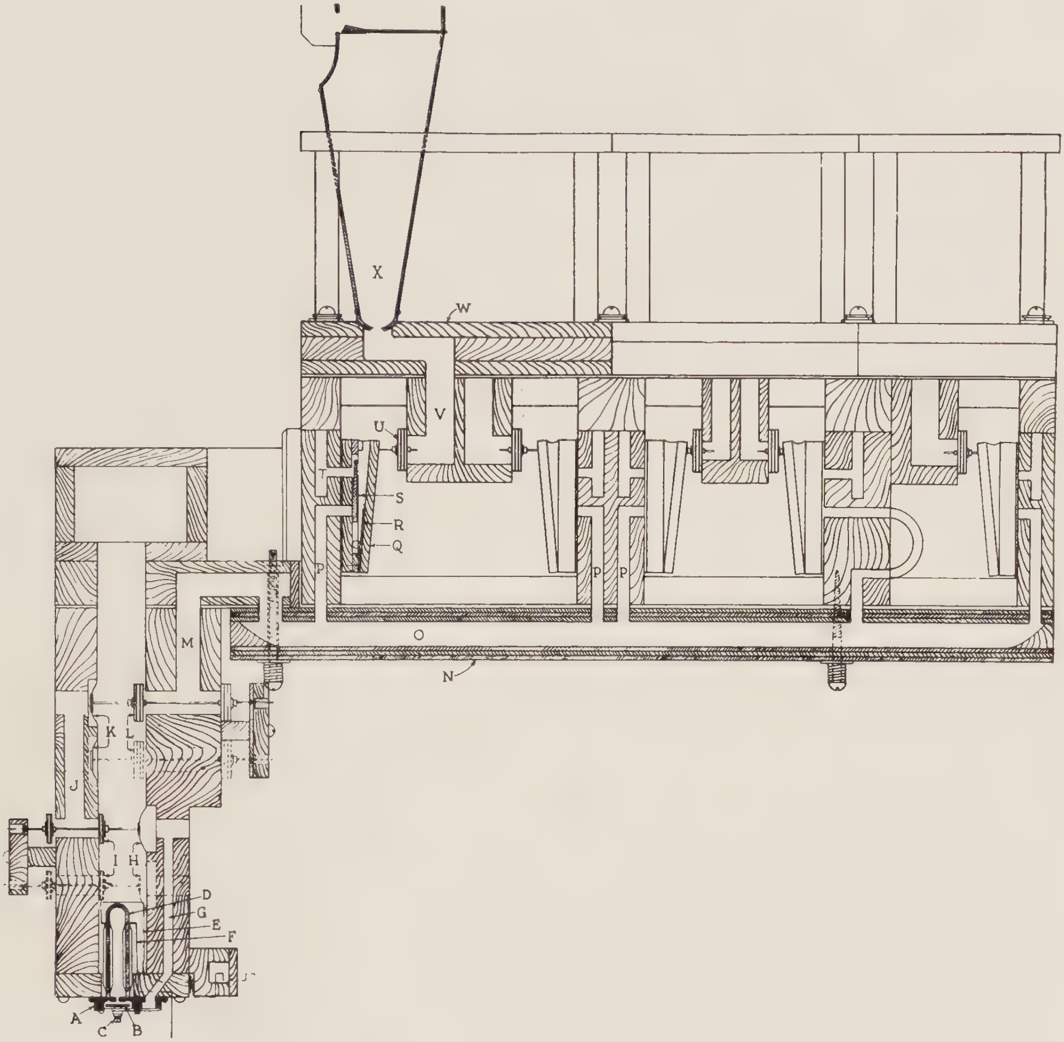


Figure 81.

Section through the windchest employed by Henry Pilcher's Sons of Louisville, Ky. The operation of this windchest is described in the accompanying text.

He states in referring to Figure 81, the following:

"The pipe valve pneumatic is made with a hollowed-out base, in which is located a rocking check valve covering two airports. One of them from the groove supplied by the stop action and which is common to all of the pneumatics of the stop; the other from the channel supplied by the key valve action, allowing the air to enter one pneumatic of each stop.

"This check valve is made of a thin piece of poplar or bass wood and is covered with a light pneumatic leather, the leather being glued to the wood only where it seats over the airports, thus forming a flexible hinge in the center, which is glued to the base of the pneumatic, and thus permitting the check valve to rock and cover or uncover either of the airports. Beyond this point the action is practically the same principle as is used in the pitman chest.

"The air to the pipe entering through the side of the valve bar and then passing up through the top board to the pipe, gives a little flexibility to the wind and we believe aids materially in the tone produced in the pipe, the attack not being so sudden as when the valve is placed on a pouch directly below the pipe."

THE VENTIL WINDCHEST WITHOUT INDIVIDUAL PIPE VALVE PNEUMATICS

A windchest action that has some similarity to that made by the Austin Organ Co., though in other respects quite different, is that made by Hillgreen, Lane & Co., of Alliance, Ohio. It has for its basis the early type of ventil windchest made by Walcker in Germany some fifty years ago, though it has been simplified and improved by the American builders who use this action. Its similarity to the Austin system is in having one primary motor that draws the pipe valves open mechanically, by means of a tracker or wire, thereby not requiring individual pneumatics for each pipe valve. I am indebted to the builders for the drawing of their action shown in Figure 82. It will be noted by an inspection of the drawing that the windchest does not contain universal wind, as in the Austin air chest, but has separate air compartments under each series of pipes. This is a characteristic of all forms of the ventil chest.

Wind is admitted, by means of a ventil in the end of each stop compartment, in a similar manner to that described for the ventil windchest with individual pnuematics for each pipe. When the stop action is open, wind is admitted to the compartment under its respective set of pipes, so that the pipes will speak if the pipe valves are opened. With the ventil closed, no wind is admitted, so that the pipes will not speak, when the pipes valves are opened. Such stop action is simple and re-

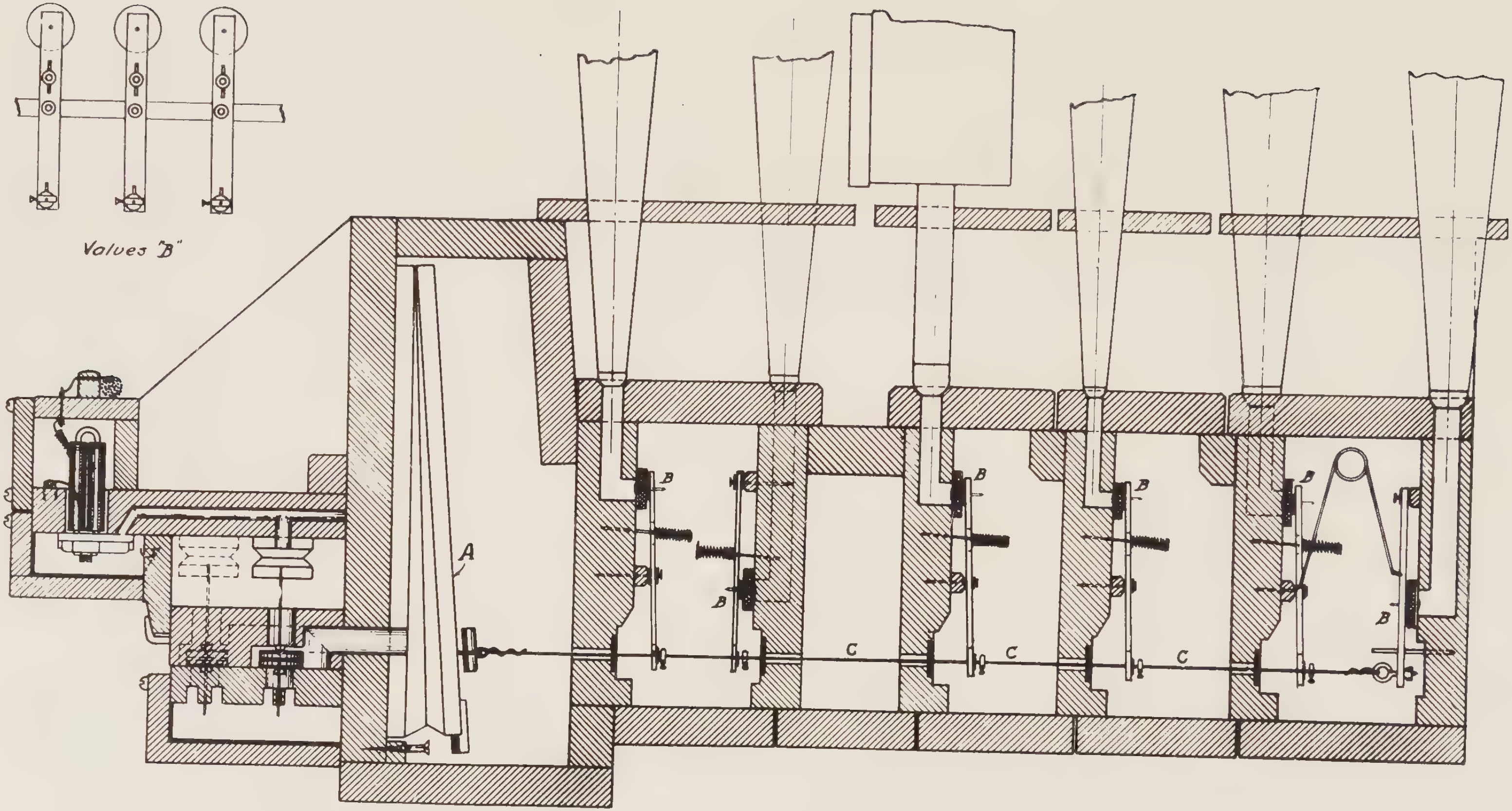


Figure 82.
Section through a Hillgreen, Lane & Company Ventil windchest. The operation of this windchest is described in the text.

liable. It certainly is a great advance on the slider stop action universally used for hundreds of years.

It will be seen by a further study of the drawing that the large primary pneumatic A upon being exhausted through the primary mechanism (in a similar manner to that previously described in detail for the Austin primary), draws with it a phosphor-bronze wire CCC that passes through all the compartments of the windchest. To this wire is fastened the various pipe valve levers, by means of a collar with a set screw, so that the proper adjustments may be made. The pipe valve mechanism consists merely of felt and leather glued on a fibre disc, shown at B, which is fastened to one end of a pivoted lever, while the other end of the lever passes through the wire. A spring is provided to return the valve to its seat.

It is important that the wire CCC as it passes through the separate air compartments fit practically air tight. This is accomplished by passing it through a brass plate with a hole just large enough to allow the wire to move freely, without leaking wind from one compartment to another. The pulldown wires in the old tracker windchest passed through similar brass plates where these wires emerged from the interior of the chest. A strong spring at the end of the windchest returns all of the mechanism to the "off" position immediately that wind is again admitted into the large pneumatic A.

The bottom part of each section of this windchest may be removed by taking out a few screws, which permits of ready access to the pipe valves for adjustments and replacements when necessary. It will be seen, from a careful perusal of this drawing, that the action requires a very small amount of boring of holes and other channeling as compared to the more usual type of modern windchest. When once carefully adjusted, this action should operate very satisfactorily.

A certain amount of play or lost motion is left at the point where the pipe valve levers connect with the wire CCC that is drawn by the primary pneumatic. Changes in atmospheric conditions, with consequent swelling or shrinking of the wood of the windchest will not cause the pipe valves to be drawn from their seats, with this additional play provided, which might otherwise occur, as the pneumatic might not open sufficiently wide to permit the pipe valves to seat properly. Thus the possibility of ciphering from this cause is overcome. Such a system of construction lends itself best to a small number of stops on each section, so that the phosphor-bronze wire is not too long or does not have to pass through too many brass plates. In the case of large manual divisions, two or more windchests may conveniently be provided, which will serve both to speed up the action and to provide each section with steadier wind.

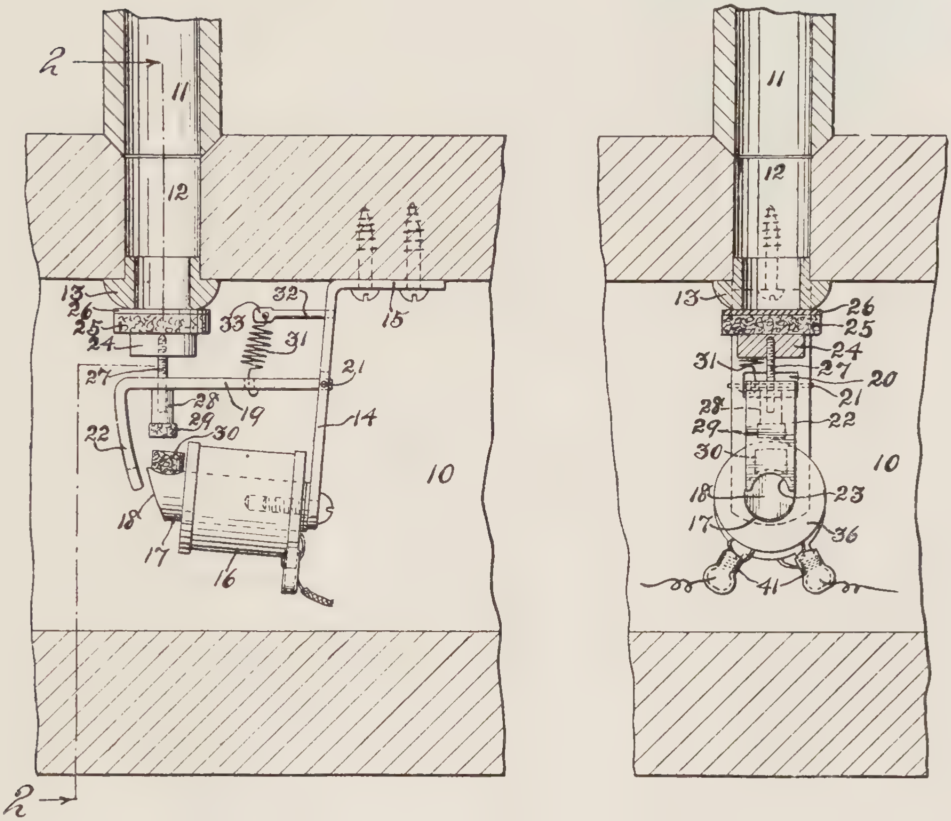


Figure 83.
Side and front views of the Wicks Direct Electric Action.

THE DIRECT ELECTRIC ACTION

An organ action, and windchest mechanism, known as the direct electric action has been invented by Louis J. Wicks, of the Wicks Pipe Organ Co., of Highland, Ill. We are able to furnish drawings of this mechanism taken from the patent specification granted to Mr. Wicks, November 19, 1929. J. S. & C. H. Odell Co., of New York, have also a direct electric action, as well as the Estey Organ Co., of Brattleboro, Vt., which they sometimes employ, in the case of small organs. The Wicks company is the only builder that has consistently employed such an action over a period of years.

In this action the mechanism has been brought to perhaps its simplest form. It consists merely of an electro-magnet which directly draws the pipe valve off its seat, thereby admitting air to the pipe. No pneumatics of any sort are required and electricity does all the work.

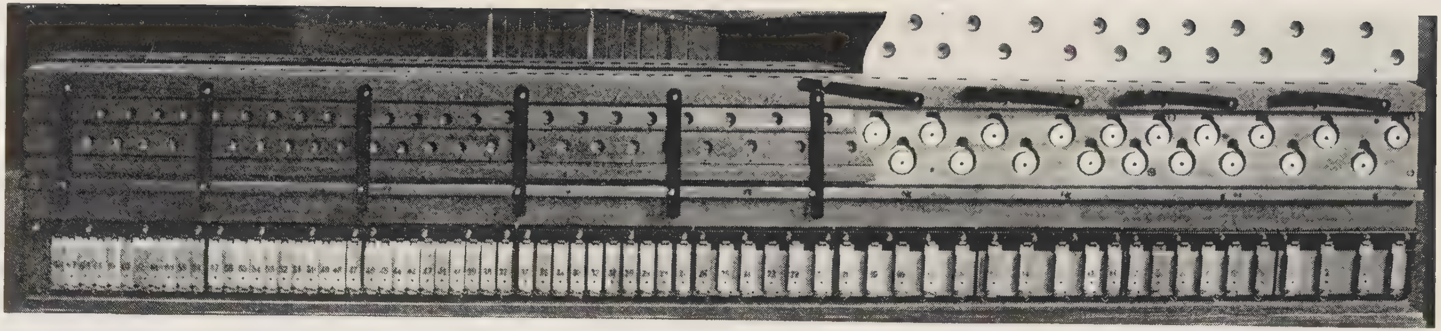


Figure 84.
Windchest auxiliary of Casavant used on their early electric organs.

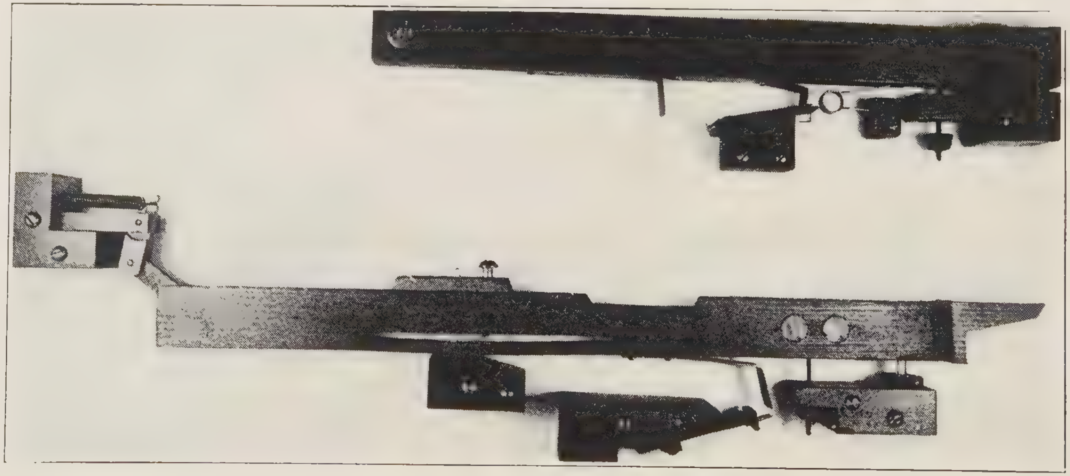


Figure 85.
Two forms of key contacts used by Casavant. The lower one was first used in Montreal Cathedral in 1893. The upper one in St. Patrick's Church, Montreal.

The operation of the action is as follows: We are referring to Figure 83. Upon the coil 16, being energized with current, the core of the magnet 18 becomes magnetic, and attracts the armature 22, which is pivoted at 21. This armature has connected to it the pipe valve disc 25 that is drawn away from the valve seat 13, as a result of this attraction. The spring 31 returns the armature and valve disc as soon as the coil is no longer energized with electricity, to their original position.

This seems to be the ultimate in simplicity in organ action. Unfortunately it requires a magnet for every pipe in the organ. In cases where the organ is small, not exceeding a few hundred pipes, the demands for current are fairly reasonable and the action can be made to work satisfactorily. When the organ assumes larger proportions, the number of magnets required to be operated every time a key is depressed may reach into the hundreds, so that the current consumption becomes a real problem to cope with. Particularly, as the magnets must be made considerably more powerful and require greater current consumption for the lower notes. These notes require larger valve discs, and much greater power to pull them open against the wind pressure. It should appear from this that such mechanism should be confined to small two or three manual organs, and with moderate wind pressure only being employed. If higher pressures are used, the current consumption is greatly increased, in opening the valves (as the pressure against the valves is increased). A large number of magnets must be operated inevitably in a large organ with this system, and the demands for current become so excessive as to constitute an almost insuperable obstacle to successful operation. Burned contacts and other troubles are almost sure to follow. No one has yet proved that one can get something for nothing in organ building or anywhere else.

In every organ there is, or should be, ample air pressure available which is a much more reliable means of opening the pipe valves. To allow the air pressure to do most of the work and to allow the magnets to do the minimum amount in setting the train of mechanism into operation is still the most practical solution of the electric organ action. When air pressure is employed, high wind pressures are an advantage rather than otherwise to the speed of the action. High wind pressures are obviously a great disadvantage to the direct electric action, and nothing higher than 4″ or 5″ has been successfully used.

The direct electric units already described may be mounted on an air box in any position anywhere, as no boring of holes other than the pipe holes or any channeling is required. All other intervening mechanism is eliminated. Only a switch is required for the stop action, thus

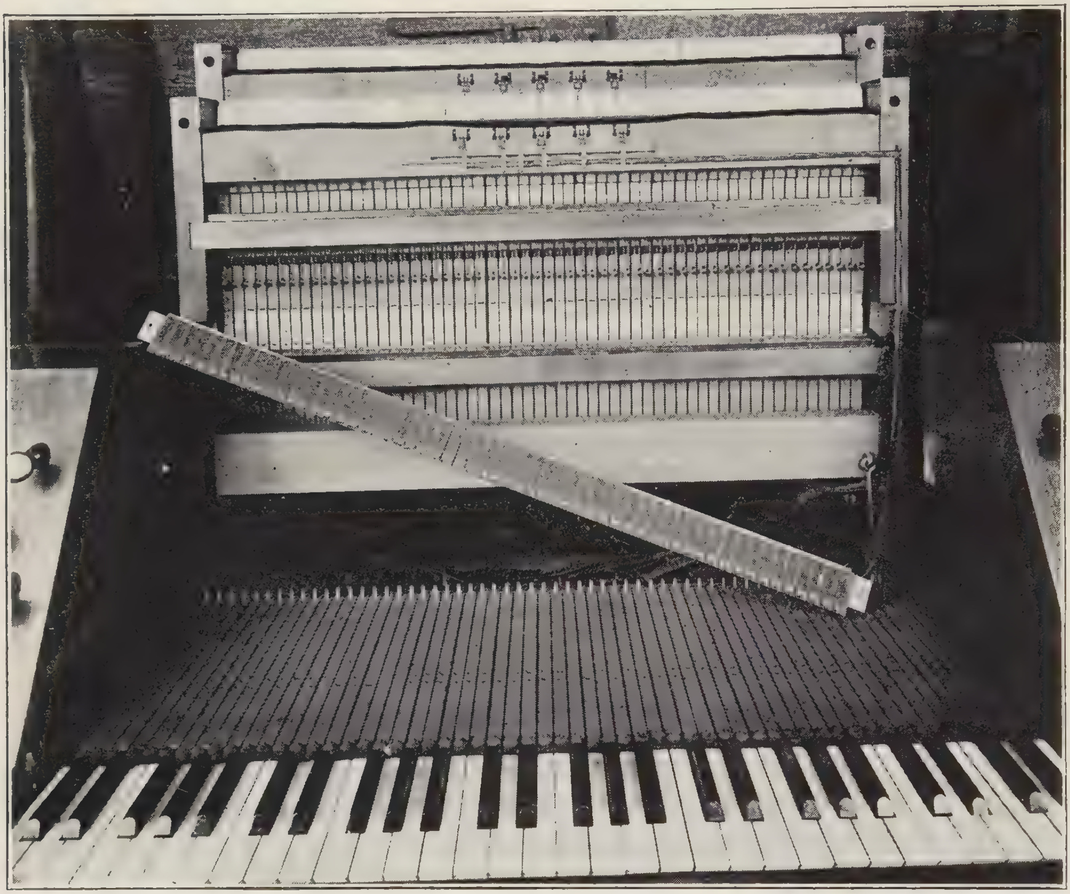


Figure 86.

Keys of the console in St. Patrick's Church, Montreal, Canada. One of the contact bars has been removed, which clearly shows the platinum tipped contacts. Very few changes have been made in contact bars by builders who use these types to-day. This was built by Casavant in 1895.

avoiding ventils, pitman valves, and all other stop action mechanism. A cable connects the magnets in the air box to a switch, which permits the pipes on each air box to be connected or disconnected with the key mechanism. By a series of switches a stop may be used at any or all pitches on any keyboard. Such an action lends itself to unification with the utmost ease.

The Wicks Organ Company have been building a large number of small organs on this principle with good results. They have been enabled to sell them at a lower price than other builders must necessarily get to build the more elaborate and costly systems that they use. Very few other builders have thought it worth while to adopt the direct electric action, though many forms have been tried by others.

The simplest and most economical action yet invented may advantageously be applied to small organs. I believe its use should be limited to such organs, at least in the present state of the art. To date, the theoretical possibilities of the direct electric principle holds much more promise and interest to the student of organ actions than it has been found possible to actually deliver in the practical application of such principles.

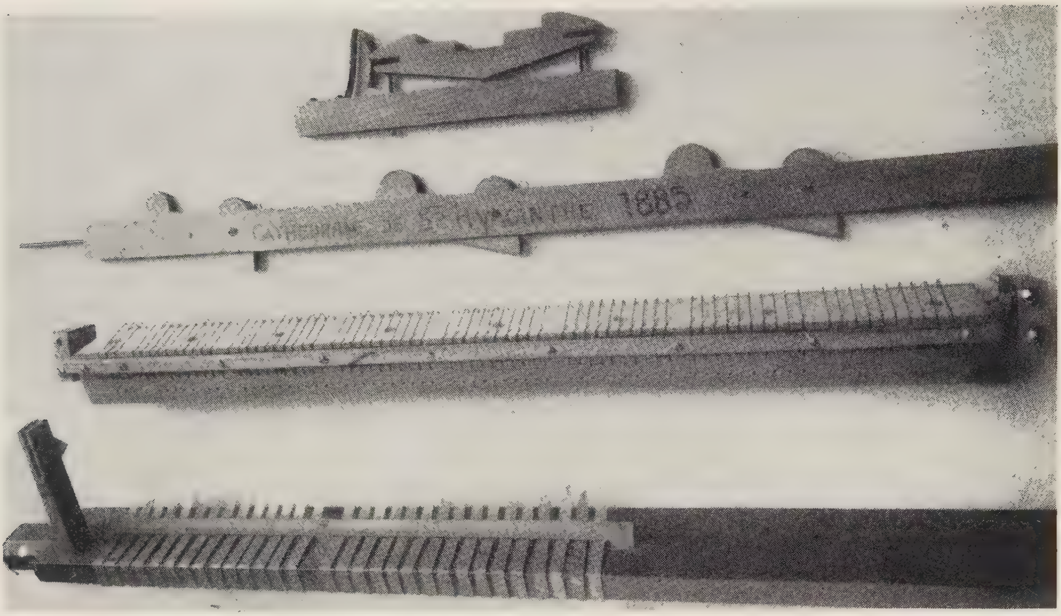


Figure 87.

The lowest portion of this photograph shows the original coupler switch used by Casavant in their first electric console at the Cathedral, Ottawa, Canada. The coupler switch above is the one used for the first time by Casavant in 1895 in St. Patrick's Church, Montreal, Canada. This is essentially the form of coupler switch used by nearly all American builders.

The upper portion of the photograph shows some combination rockers that were used for the first time in 1881 and in the Cathedrale de St. Hyacinthe in 1885. This was apparently the first adjustable combination mechanism installed in an organ. It was invented by Dr. Sallust Duval who was at the time associated with Casavant. Mr. Frank Roosevelt secured the patent rights from Dr. Duval in 1889 and modified the form to that shown at the top of the photograph, known as "the rocker and two pins" type. Casavant's original form is very similar to that which is now being used by several leading builders.

CHAPTER 19.

SPECIFIC EXAMPLES *of* MODERN CONSOLE ACTION

KEY CONTACTS AND COUPLER ACTIONS

FROM our general description of the electro-pneumatic action, it should be clear that the movement of the keys, registers, and other controls, by the organist, results in "making" or "breaking" contacts, which in turn close or open one or more electrical circuits or complete paths of current between the contacts and the magnets in the organ. Figure 90 shows a form of contact block that is used beneath each key of the console, which is employed by several leading builders. The Aeolian, Casavant, Estey, Hall, Kimball and Skinner Companies and several other builders employ this type of contact block with small modifications in each case. Wires of silver or phosphor-bronze are inserted in a series of saw cuts in a hard wood block in the manner shown in Figures 89 and 90. When a key is depressed all the separate wires make contact with a silver or phosphor-bronze plate that is connected with the feed wire.

From the contact blocks the circuit leads to the coupler switches. These are a series of additional contacts (one for each note) arranged in a row, as shown in Figures 87, 88 and 110. A circuit runs from a single contact under a given key to a corresponding contact on a coupler switch.

Considering Middle C on the Great manual for example, a wire will run from one of the contacts on this key to a point on a switch corresponding with middle C, where the circuit may be broken or made once more. From the switch the circuit runs to the middle C magnet on the Great windchest primary box. In other words when this switch is in action (that is, closed), the magnet operating the primary valve which permits all the middle C pipes on the Great windchest to sound, is energized. This action takes place every time the middle C on the Great manual is depressed, and the switch closed. Another contact on this same key will run to another switch. From this switch the circuit runs to the magnet on the Great windchest primary which operates the pipe valves of C above middle C or C below middle C; in other words, an octave higher or lower. The first switch is known as the Great Unison Coupler or Great to Great 8′. The other switches are the Great to Great 4′ or Great to Great 16′ couplers. Similarly other contacts on the same key will run to other switches, which in turn will continue circuits to the middle C magnet on the Swell Organ primary box for the Swell to Great 8′ coupler and so on for all the couplers. The number of contacts

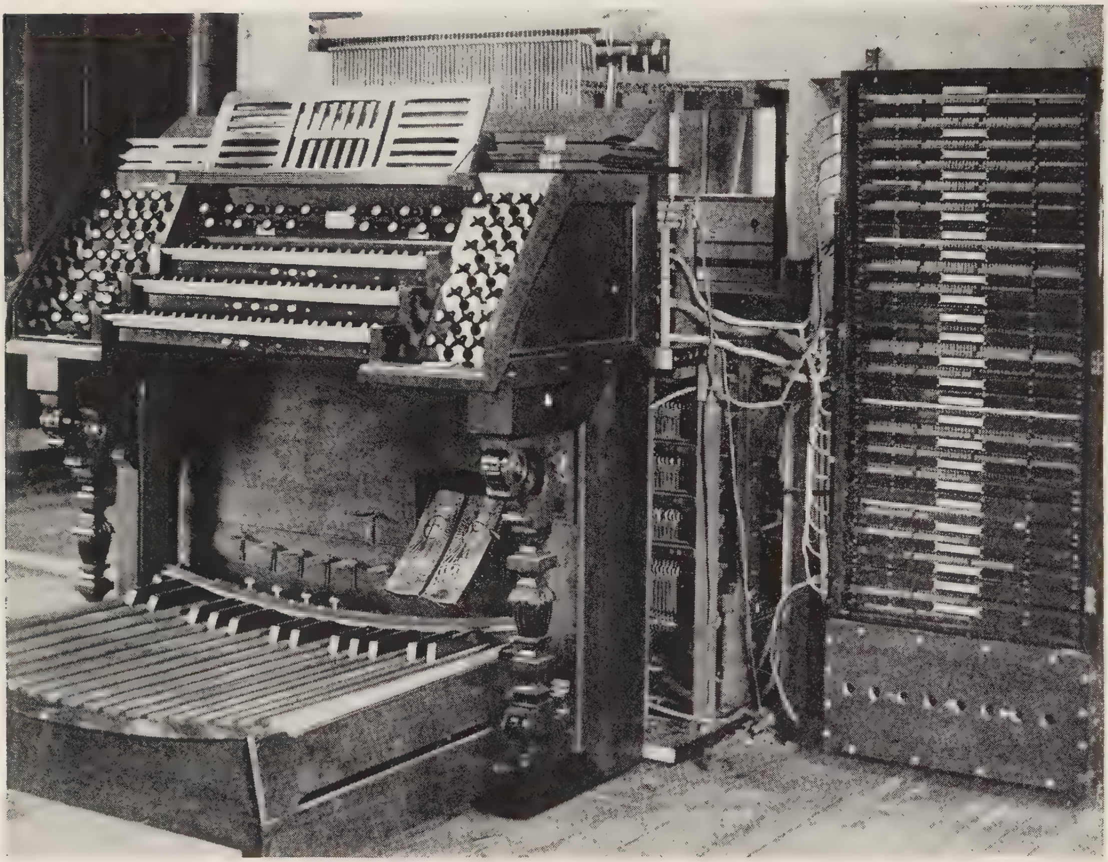


Figure 88.

Console of the Cathedral at Ottawa, Canada. It is the first electric console built by Casavant Freres, back in the 1880's. They did not have sufficient confidence in this action at the time of building to rely solely upon it. A close inspection of the photograph will reveal some tracker action way up in the back of the console. This was for the Great organ only. It enabled a portion of the organ to be played in case the old style batteries gave out suddenly through accident or neglect. This console is still in use. The switches shown at the right of the photograph are of the type shown in Figure 87, lowest quarter.

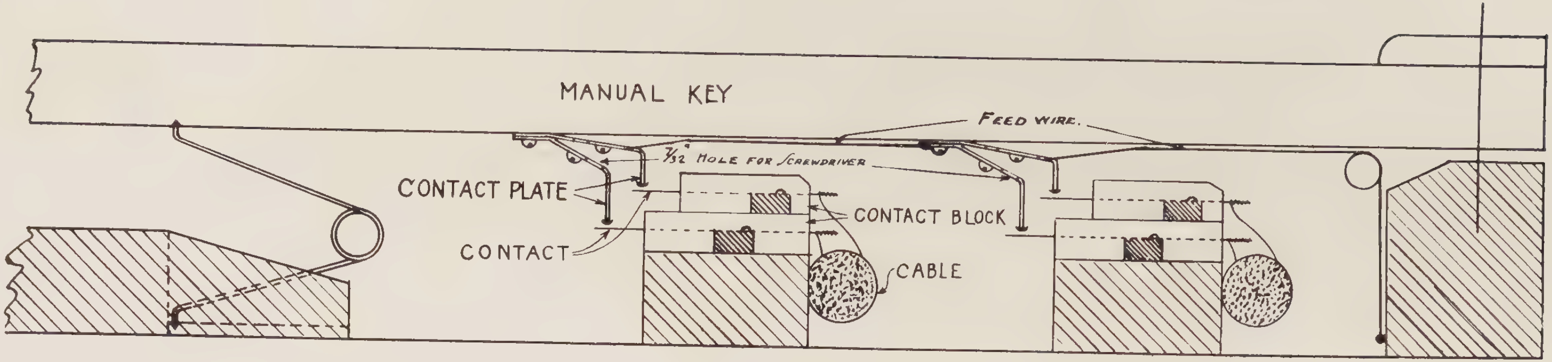


Figure 89.

Side view of a Kimball manual key, showing the method of installing four contact blocks under a single key. In this manner as many as thirty-six contacts may be made by one key directly, without the use of a relay.

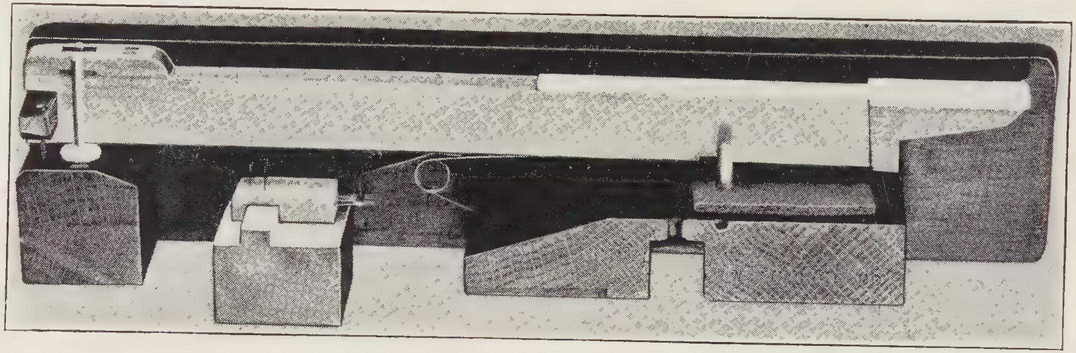


Figure 90.

Photograph of the Kimball manual key, showing the location of the contact block, at which point the circuits are closed that lead to the coupler switches for the various divisions. This type of contact is used by several other leading builders.

under each key is governed by the number of coupler switches desired.

If no switches were provided, all these circuits would be closed by the series of contacts actuated by depressing the middle C key. In such a case all the middle Cs on all manuals as well as the octave above and octave below would sound. The switches permit the "making" or "breaking" of these circuits at will. They are therefore an indispensable adjunct of the action, and it is as important to be able to "make" and "break" the various circuits leading to the organ magnets through the switches, as it is at the key contacts.

The pedal key action is the same as the manual in nearly all cases. Figure 91 shows the Austin key action. In this case the key contacts and coupler switches are combined, resulting in a somewhat simplified construction. In this action, the key contacts only "make" (when a key is depressed) if one or more of the coupler switches are in position to permit contact to be made. If no switches are on, no contacts will be made when the key is operated. The circuits from the various switches run to a junction board on the console and there the circuit is completed to the magnets on the windchest as in the case of the switches where contact is not made directly by pressing a key. Further description of the Austin Coupler System is given under Figure 92.

Figure 93 shows the Moller key action. In principle it is similar to the Austin though the details of construction are quite different. The explanation of its operation is given under the drawing.

Figure 94 illustrates the Kilgen key action. This is so nearly like that of the Moller Company as to require no further statement in regard to its operation. In this action, however, silver contacts are used, whereas in the Moller flat strips of spring phosphor-bronze perform the same function in their standard action. Silver contacts are used when requested.

Another form of key action shown in Figure 95 is that made by Hillgreen, Lane and Company. Its principle is a modification of the Austin system also.

From the foregoing, it should be evident that there are two general types of key and coupler action. One has a contact block under each key on which all contacts are made whenever a key is depressed and then the circuit is "made" or "broken" as desired by means of independent switches not operated by the key contacts directly. The other type makes only the contacts desired directly on the coupler switches.

COMBINATION ACTIONS

The chapter on the History of the Organ Console contains historical information concerning the earlier development of combination actions.

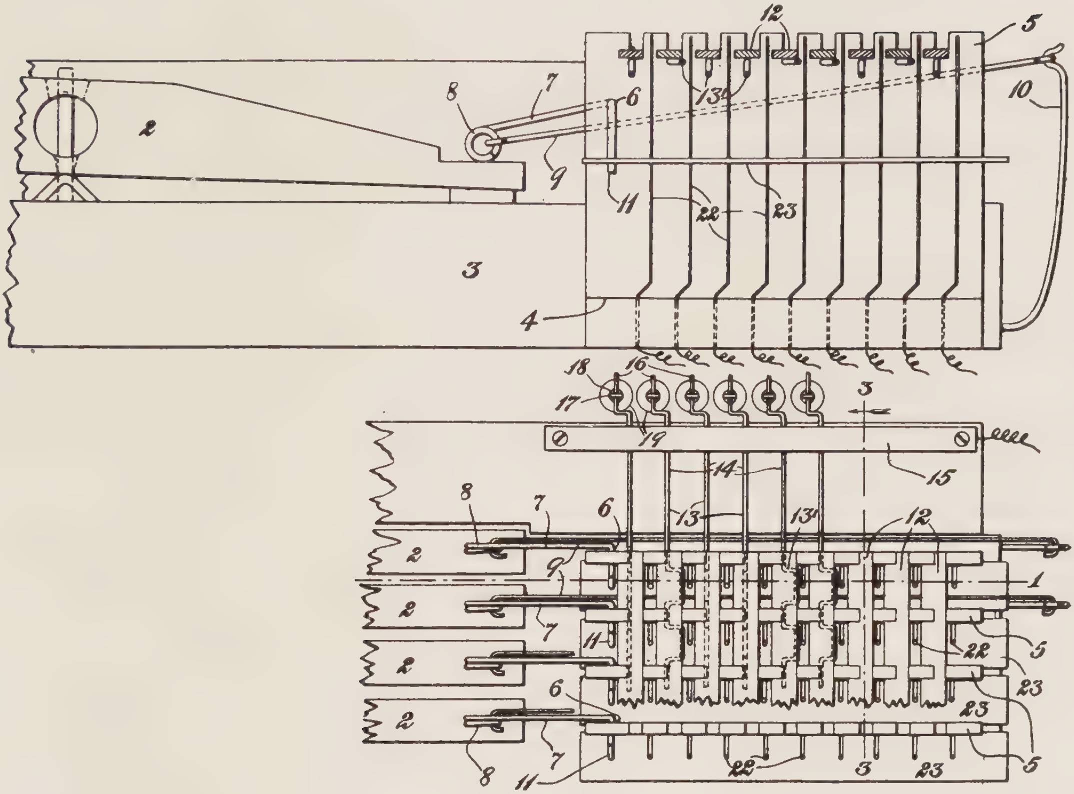


Figure 91.

Side and top views of the Austin key action. 2 is the back end, or tail of the key. When the tail of the key rises, it causes the strip, 23, to be drawn forward; this strip controls all the contacts, 22. The contacts will strike the wooden stops, 12, unless a coupler roller is in playing position, in which case the roller projects beyond the wooden stops, and allows the contacts to rub against it. The key spring is shown at 10, and with its attendant wire, 9, combines to form the "tracker" touch of the Austin, that is, a touch that is heavier at the beginning of the downward motion of the keys, than at the end.

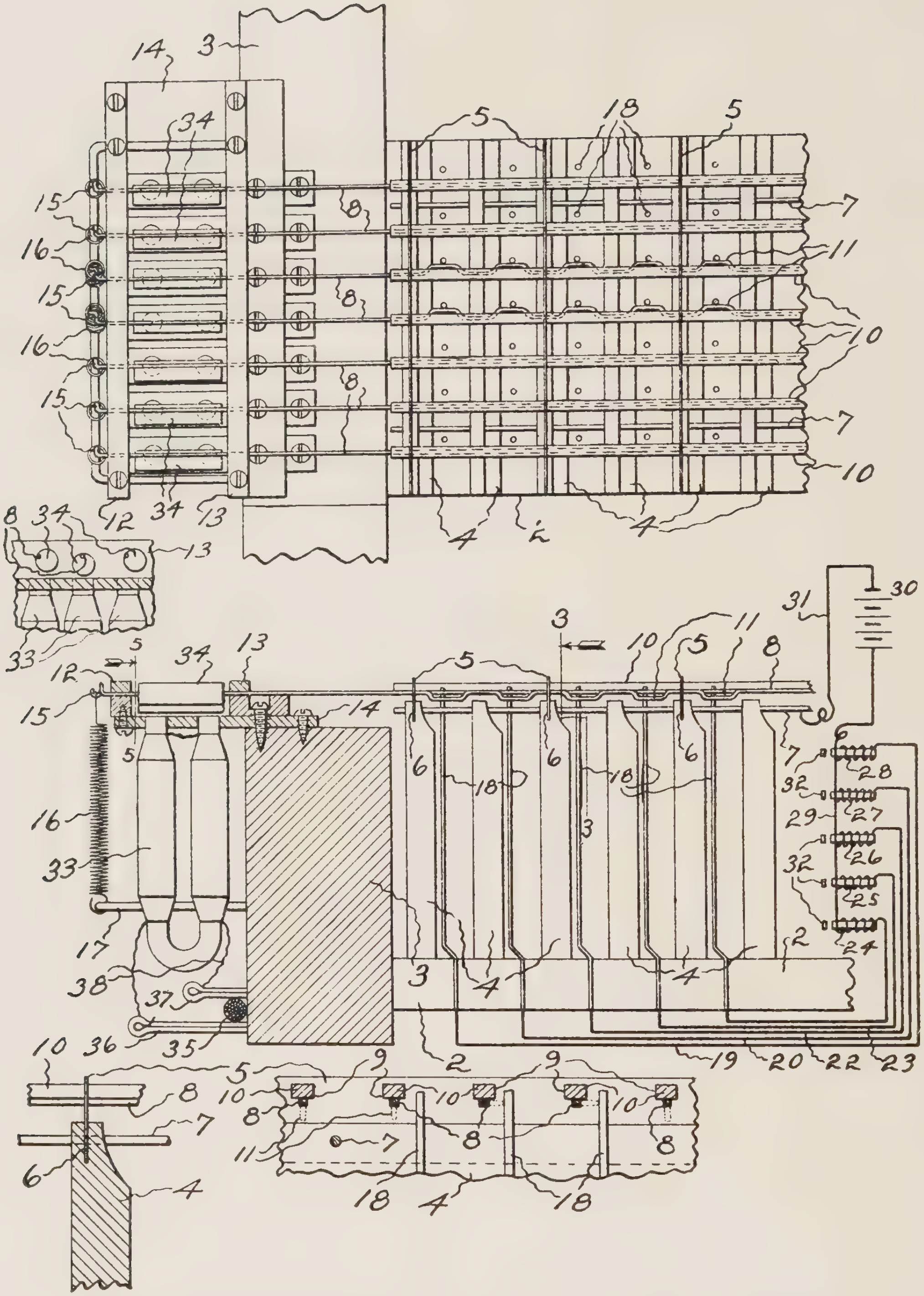


Figure 92.

Top and side views of the Austin key action (Coupler Rollers). The silver wire key contacts are shown in Figure 91 more clearly. They are here labeled, 18. The silver wire rollers themselves are shown by number 8. On the end of these rollers is soldered an armature, 34, that is attracted by the magnet, 33. The armature will cause the roller to rotate about a quarter circle, when attracted by the magnet, and cause the rollers to assume position shown at 11. When in this position, the contacts will make against the roller. When the magnet is not energized, the spring 16 pulls the roller back to position shown at 10, where the roller is inoperative, as the key contacts then merely strike against the wooden strips, 10.

The drawings furnished in the following pages show the various systems employed by some of the builders and are provided with explanations, so that it is only necessary to state that combination actions may be divided into two major groups: 1. Those that may be set by holding the piston in, on which the combination is desired, and at the same time moving the stop controls by hand. In this manner, the cams are moved into the desired position on the trace or roller. This is the Austin system, from which many other builders have departed only far enough to avoid conflict with the numerous Austin patents. The other system is to prepare the registration desired, and then holding the setter piston, the piston on which it is desired to set this registration is pressed. The function of the setter piston is to adjust the cams, by means of pneumatics to the required set-up. This system is used by many builders, and has been developed from the original Casavant-Roosevelt adjustable combination action.

The Kimball Company have just perfected an action that permits of setting the combinations in either of the above ways, so that the organist may take his choice. An ingenious locking device (operated by the setter piston), locks all the stops in the position in which they are desired, and sets this combination on whatever combination piston is then depressed. Combinations may also be set by merely holding in the piston which is desired to be set, similar to the Austin system. When a general shifting of the stops is desired, the setter may be used. Small changes may more conveniently be made without using the setter.

When there are a large number of combination pistons required, and the console may not be made too large, a remote control system is installed. In such a case the combination setting mechanism is located usually in the organ, and transfers impulses from this point to the console, and back again to the organ. This is an indirect and expensive system, and has nothing in its favor, so far as reliability, simplicity and economy are concerned. Where the console for a large organ must be of restricted size or made movable it must be used. Figure 106 shows such a setting mechanism. Remote control does operate silently, however.

In all combination systems, the movable cams must have sufficient spring tension to prevent the motion of the cams when not intended. The tension should be sufficient to safely move the stop rollers, but not too great, as then the cams cannot be readily shifted when setting a new combination.

RELAY ACTION

When a sufficient number of contacts cannot be conveniently placed adjacent to, or under the manual keys, to accomplish all that is desired,

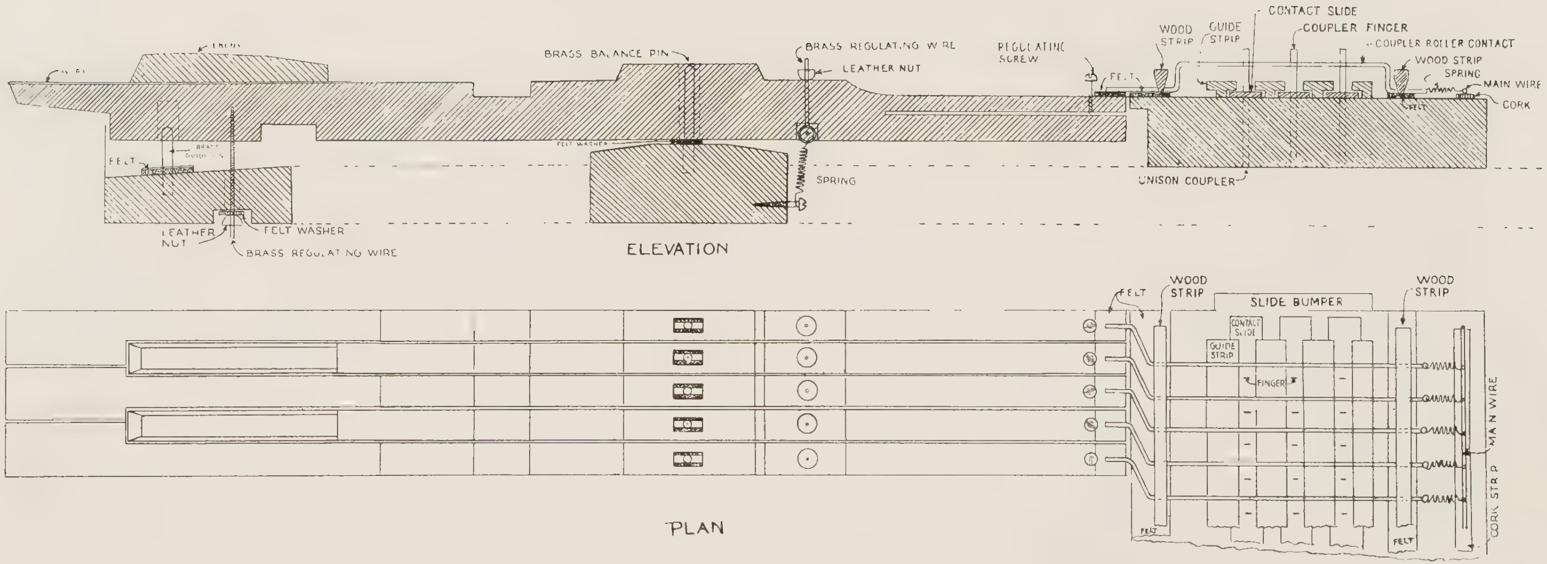


Figure 93.

Side and top views of the Moller key action. The explanation of the parts are given on the drawing. The coupler action operates the contact slides by means of a pneumatic, moving the series of contact fingers for the whole 61 keys into a position such that any key, upon being depressed will make a contact with the contact finger that has been brought into position by the contact slide.

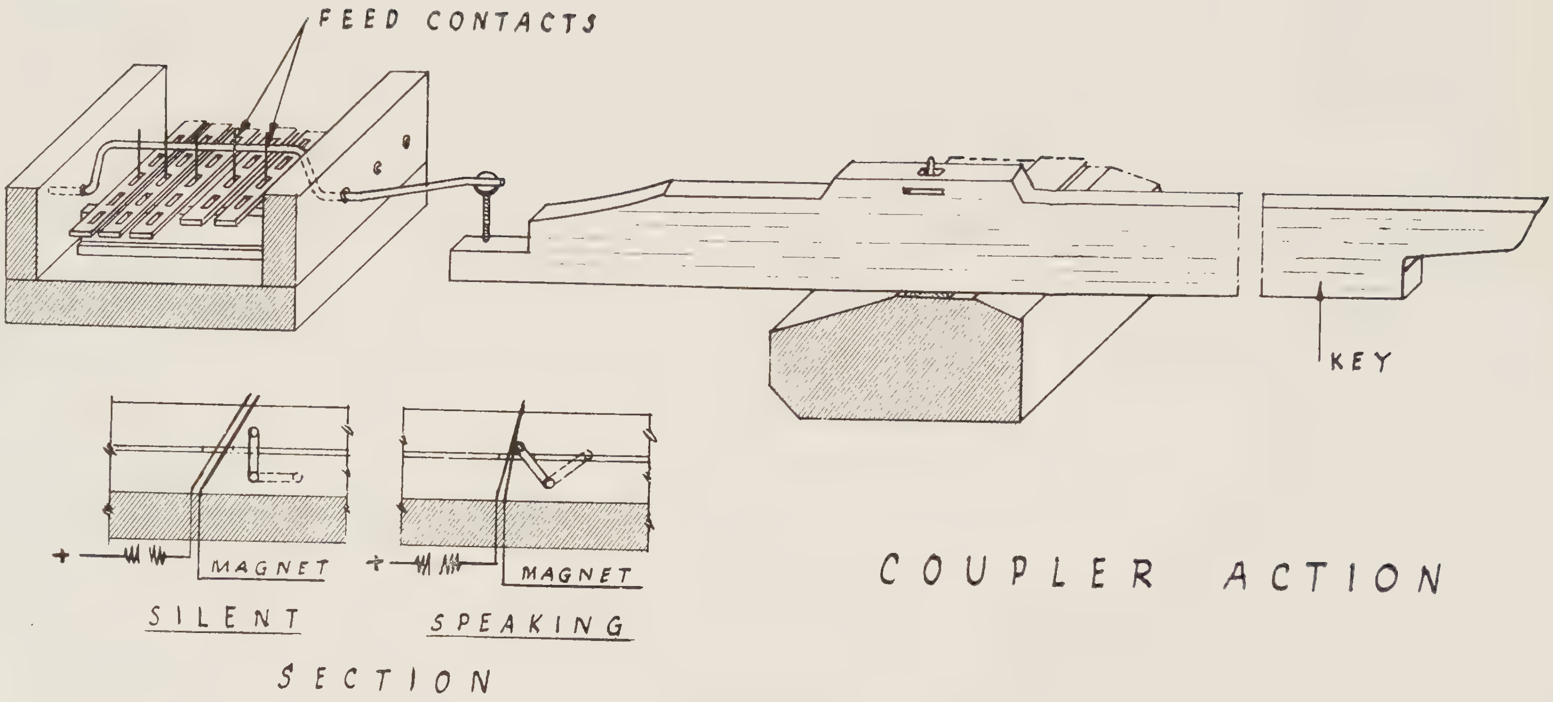


Figure 94.

The key and coupler action employed in the Kilgen organ. The tail end of the key operates a roller that rubs against the feed contacts, provided they have been pulled toward the roller, by the movement of the contact strips to the right. The lower view shows the two positions of the contact roller, when making contact, and when in the "off" position.

and especially when there are several unit stops in the organ, each of which require a large number of contacts and switches, a relay mechanism is introduced. As relays are usually placed in the organ, and are operated either directly from the windchest channels, or primary valves, or by means of an independent primary they are not in reality a part of the console.

However, in a relay, as shown in Figure 108, used by the Kilgen Company, one contact on each key is necessary at the key board to operate the relay magnets. It is possible to operate two or more magnets from the same contact, but this greatly increases the electrical load, and tends to cause arcing or burning at the contacts and should be avoided. Assuming that a contact is provided at the console for operating the magnets of the relay mechanism, it will be seen that the relay magnet operates every time a key is depressed. The relay magnet exhausts a motor pnuematic, which in turn works a roller, that will make contact with the various switches, in precisely the same manner, as when a key is depressed. In the case of the relay, the contacts are closed electro-pneumatically, while at the keyboard, the contacts are closed mechanically, by the motion of the key under the fingers.

Figure 107 is the electro-pneumatic relay used by Hillgreen, Lane & Company. Its operation is also like the key action of this builder. The only function of the relay is to provide and operate more contacts than can be conveniently operated otherwise.

The Kimball relay is shown in Figure 109. The similarity of the relay in principle to the Kimball key action is remarkable. This builder also attaches a relay mechanism to operate with the primary valve stems as shown in Figures 75 and 76. In this case, no additional magnets or pneumatics are required for operating the relay, and this is an economical and simple means.

M. P. Moller make both the electro-pneumatic relay similar to the builders mentioned, and also a relay that works pneumatically from the windchest channels. Figure 110 shows both the contact box, with the cover removed and the switches to which the contacts are connected. The manner of mounting the contact box on the windchest is shown in Figure 78.

This makes a simple and effective relay, when not too many contacts are required.

In all these relay mechanisms, the circuits from the contacts run to a series of switches. If the relay (as in most cases), is for a "unit" stop, the switches are arranged like the coupler switches in the console to complete a series of circuits. A choice is afforded the organist by these switches so that when middle C for example is depressed, not only

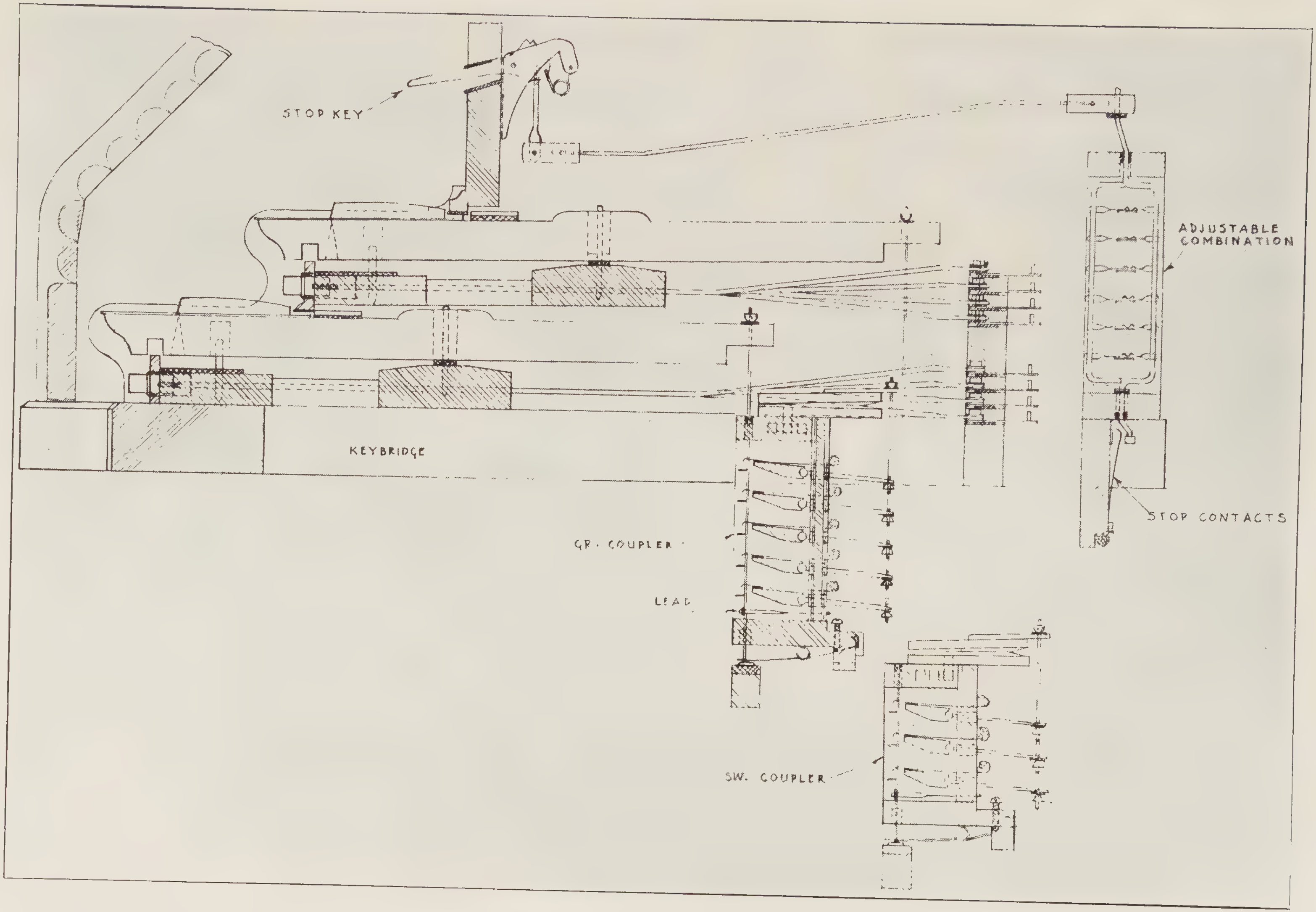


Figure 95.

Sectional view of the key and stop action in a Hillgreen, Lane & Co. console. In this action, the back end of the keys raise wires that have lugs or contact points attached to them. The coupler switches are brought in position to be affected by the contacts on the wire, by means of the power pneumatic shown. The stop action actuates a roller between which the combination traces operate. Note the similarity here to the Austin combination action.

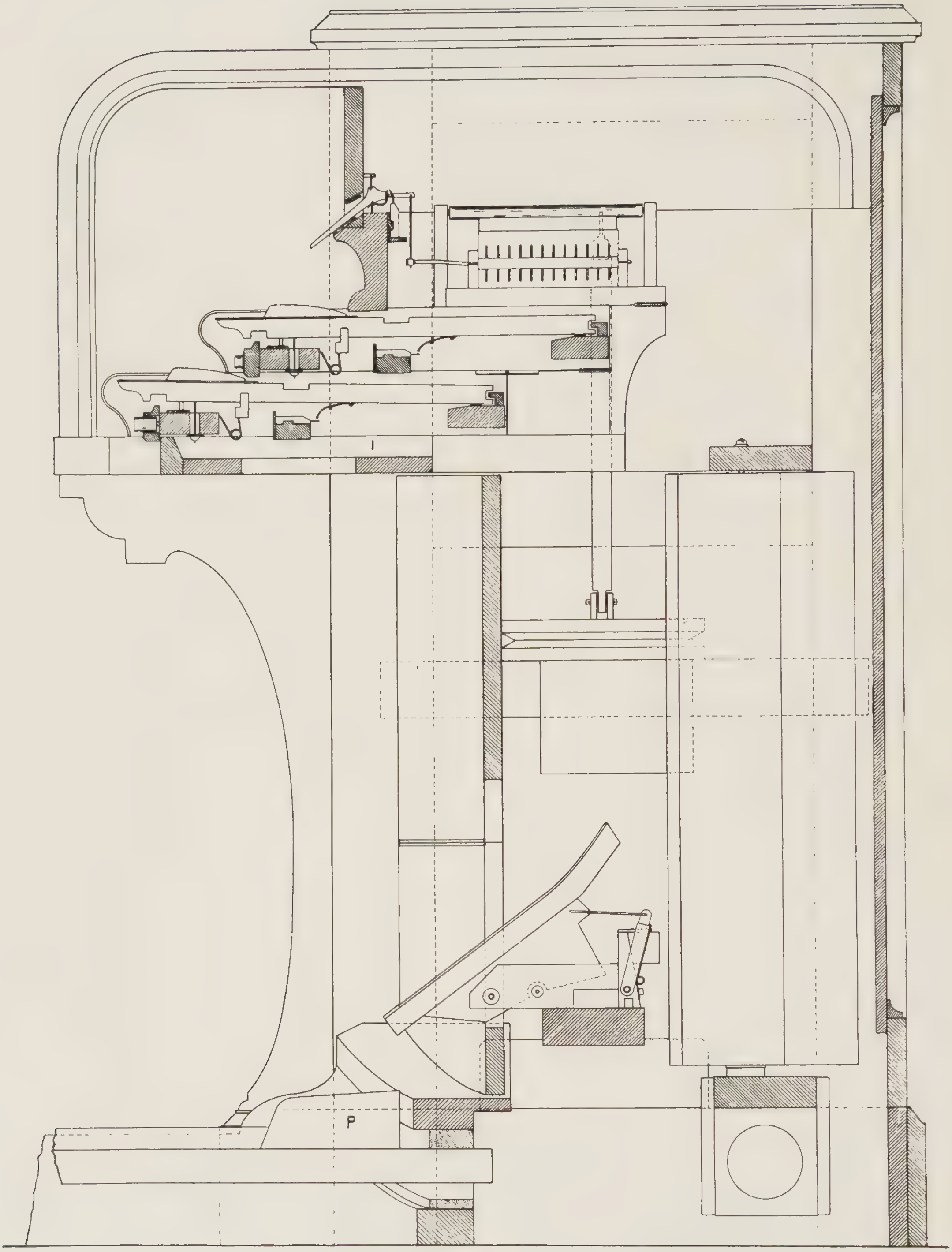


Figure 96.

A sectional view of a two manual Estey console, showing combination action above the manuals, crescendo pedal, etc.

middle C on the unit chest can be made to sound, but the C above or below, or in fact any interval, dependent on the number of switches, and the manner in which the circuits are wired. Obviously the separate relay and additional switches and wiring add greatly to the cost of a "unit" stop as compared to that of a "straight" stop. As much mechanism is required for this purpose as the entire key and coupler action of a whole manual division (if a "straight" organ). In fact the relay and its attendant switches is an independent key and coupler action applied to the operation of one or more unit stops.

There remains to be described the full organ and crescendo pedals in the console. The operation of the expression pedals is shown in Figures 36 and 37, and an explanation is there given of their function. Also toe studs, usually merely duplicate the manual pistons, or if they have independent combination traces, perform the identical operations that the manual pistons accomplish.

Figure 111 shows a form of full organ pedal mechanism and Figure 112 a crescendo pedal mechanism made by Hillgreen, Lane and Company. Ordinarily all the stop action contacts that are desired to be affected by the full organ pedal are either capable of being "made" without moving the register controls, as in the Austin system, or circuits run from these contacts to a point where they may all be closed at one time by the action of the pedal. The crescendo pedal in nearly all cases requires circuits from the stop action and coupler action, to be run onto a drum or roller, where, by turning the roller, the various contacts may be made progressively, in a predetermined manner (usually from soft to loud). Figure 112 shows one adaptation of this method.

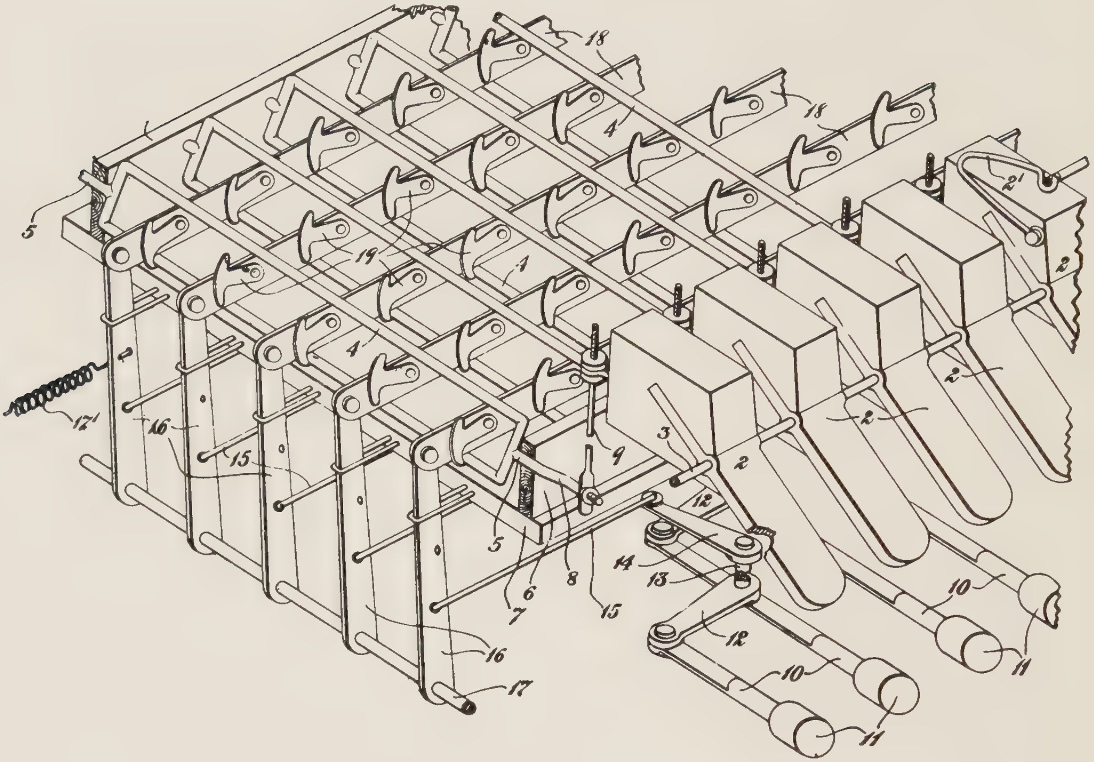


Figure 97.

General view of one of the original Austin combination actions. This at first was operated mechanically. When the combination piston 11 was pushed in, it drew the lever, 16, toward the right. The stop tongue, 2, operates a roller, 4, that permits of a series of traces being passed through. To these traces are attached a series of cams, 19, that can be shifted to either of two positions at the time the combination of stops to be drawn or shut off is set on the trace. When the cams are set in the down position, the stop key roller, 4, will be actuated and the stop key pushed down, because the trace is pushed to the right by the piston. The opposite result is obtained when the cams are set in up position. A trace is required for each piston. Cams are set on each trace to affect whatever stops are desired to be moved by each particular piston. General or universal pistons will require a complete series of cams for every stop and coupler on each trace. Manual pistons require only cams affecting stops on that manual. The roller 4 is arranged to "make" and "break" the stop action circuit, as it is rotated.

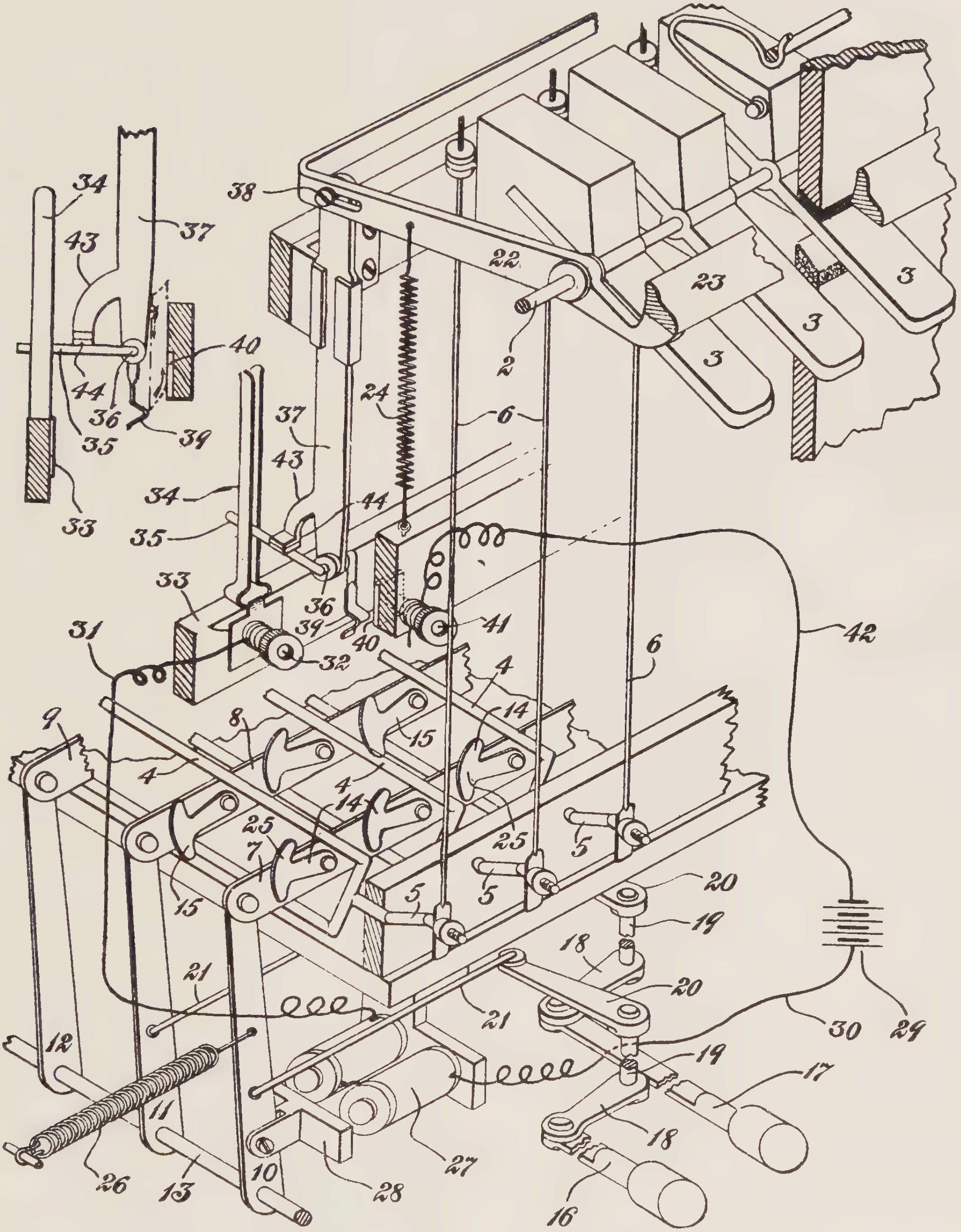


Figure 98.

Early form of the Austin Combination Action. The action is similar to that described for Figure 97.

CHAPTER 20

THE AUTOMATIC PLAYER *as* APPLIED *to the* ORGAN

A FEATURE of many organs that have been placed in residences, and occasionally some theaters and concert halls, is an automatic playing device. Automatic players have been developed by several of our leading builders, and have recently been brought to a high degree of perfection.

The need for self-playing organs was seen as far back as forty years ago, for it was found almost impossible to interest people who might be able and willing to purchase an organ for their home, unless it was capable of being played mechanically. Ordinarily the man who has requisite money has made it in some other occupation than organ playing and he is often not a musician, but merely fond of music. He must necessarily, if he would fully enjoy his organ, either have an organist play for him or have the organ provided with an automatic player.

The Welte-Mignon Company in Europe and the Aeolian Company of America were pioneers in the development of these mechanisms. It is not generally known that automatic devices were applied to the organ even before their application to the pianoforte. Early players were attached to a glorified reed organ made by the Aeolian Company which they called an "Orchestrelle" in the late nineteenth century, and soon afterwards to the organ. Like the early players developed for the pianoforte, all the older forms of organ players reproduced records that merely had the notes of the composition punched in a roll of paper. The notes were arranged so that they would sound at metronomic speed. Changes in tempo and dynamics had to be produced by the operator of the record during the performance. Such reproducing mechanisms were known as semi-automatic when applied to the organ. The stops had to be drawn and the expression pedals and controls operated by the performer—the records merely playing the notes. If the performer (for in reality it was necessary for successful interpretation for the person operating the record to be just that) happened to be musical and to know something of organ registration and nuance, good results were obtained. If not, quite the reverse was possible. In any event, nothing was done by the record but the accurate playing of the notes at regular and uniform speed.

No more than a brief account of the salient points of the mechanism of the automatic player will be described in this chapter. Nearly every one is familiar with the tracker bar, over which the paper runs in the ordinary piano player. This is usually a brass plate, with a series of

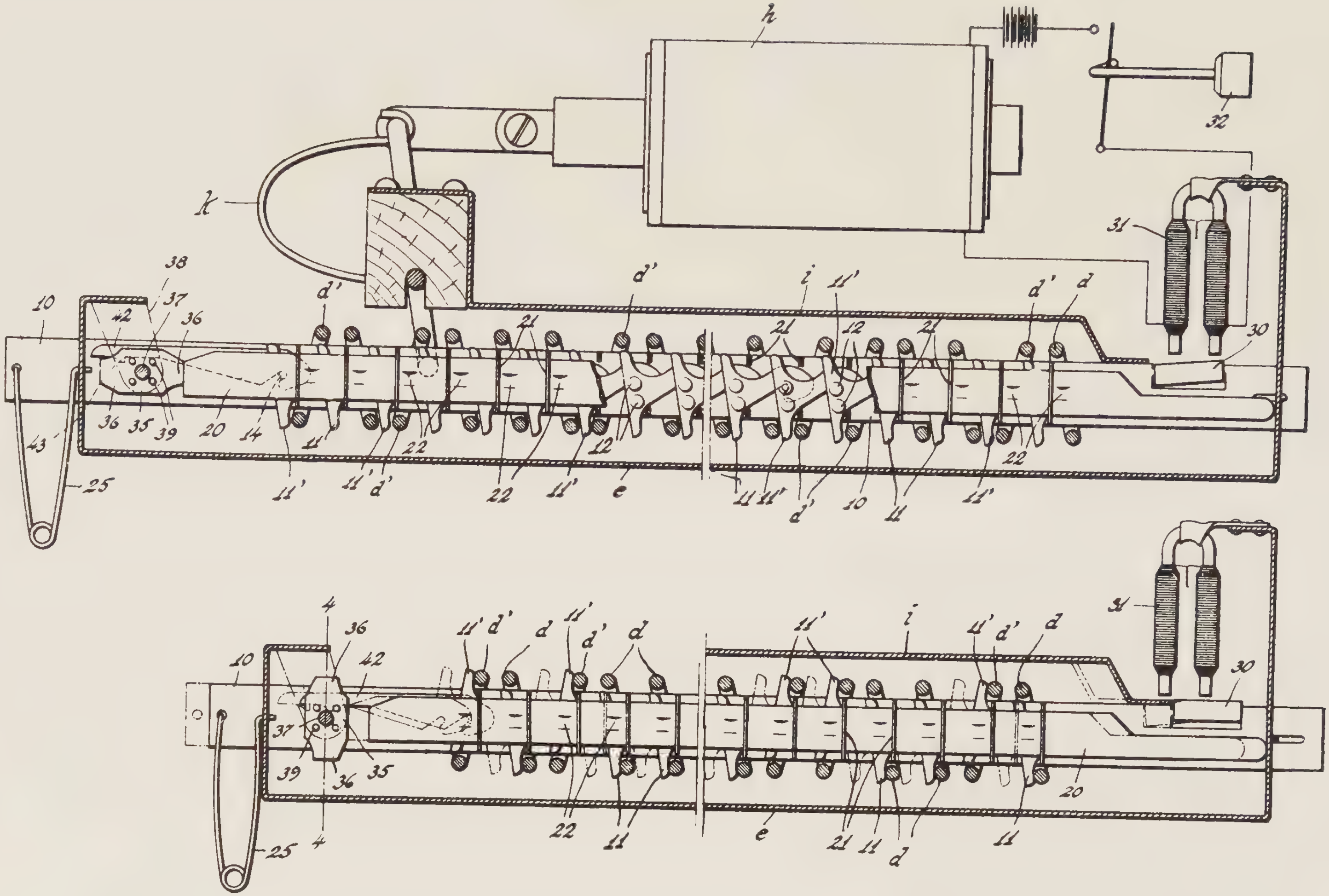


Figure 99.

The present form of the Austin combination action. 30 represents the trigger, which is in reality an armature and is attracted toward the magnet 31 when a combination piston is actuated. This enables the fan, i, to push the trace 10. The large solenoid magnet h acts a little later than the magnet 31, so that the trigger 30 is drawn into position before the fan starts forward. This is essential to the operation of the action. To the trace are connected the series of cams 11, which in turn rotate the stop action rollers d to the right or left, in accordance with the way the cams are set on the trace, whether in position to draw the stop on or off. There is one trace with its series of cams for each piston. The series of traces may be placed compactly in the Austin console, passing through the stop action rollers. These rollers are more clearly shown in Figures 97 and 98.

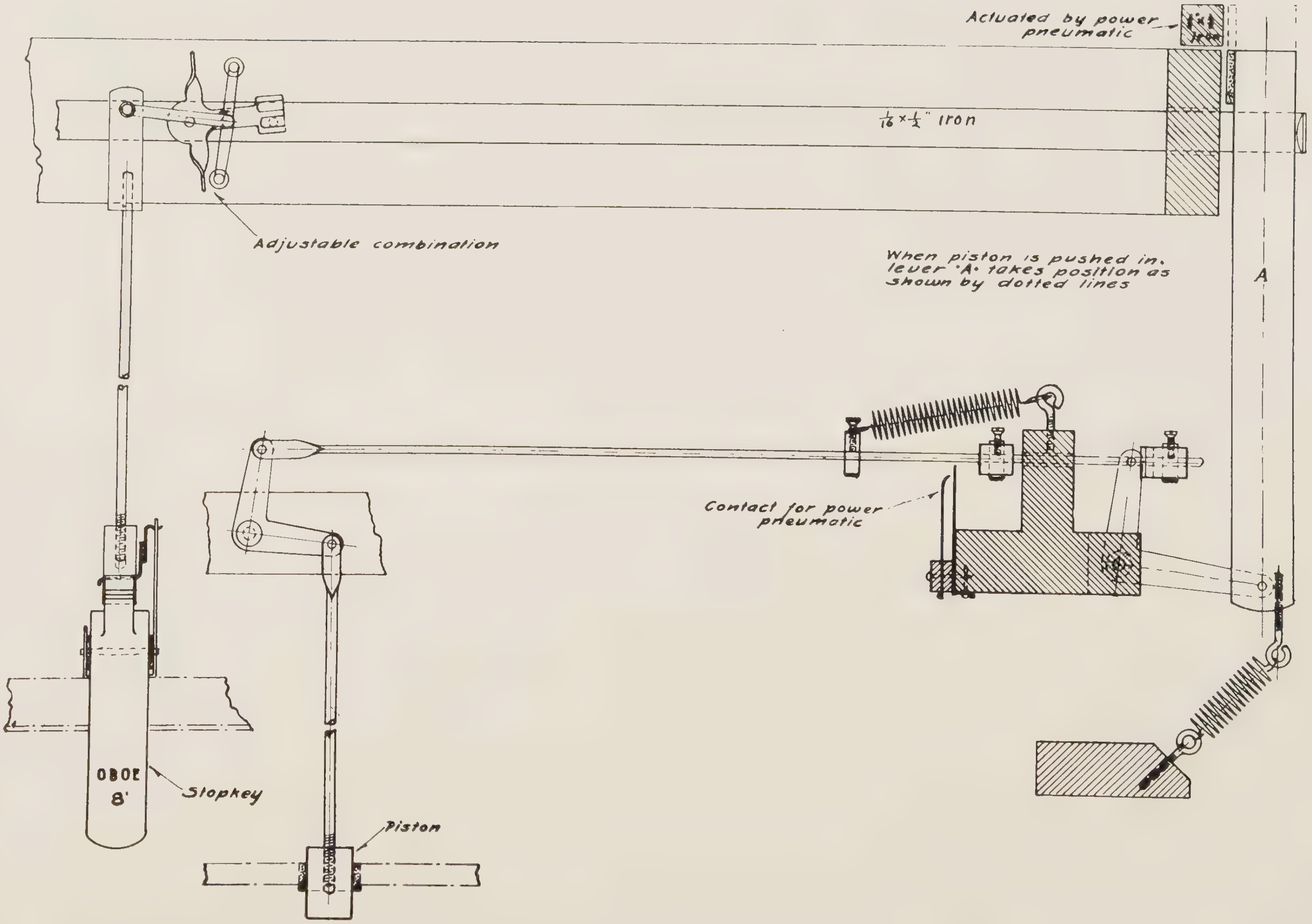

Actuated by power pneumatic
1/16 × 1/2" iron
Adjustable combination
When piston is pushed in, lever ·A· takes position as shown by dotted lines
A
Contact for power pneumatic
OBOE
8'
Stopkey
Piston

Figure 100.
Working model view of the adjustable combination action made by Hillgreen, Lane & Co.

holes bored at regular intervals, one for each note on the piano keyboard, or eighty-eight. Earlier players had a shorter compass than this. When the paper passes over this series of holes, it forms an air tight seal, if no holes are punched in the paper. When a perforation occurs, it allows air to escape or enter into the particular hole in the tracker bar corresponding with the hole punched in the paper. By a series of rubber tubes, the tracker bar is connected with small pneumatics. The pneumatics, therefore, are controlled similarly to the manner in which the tubular pneumatic action of the organ operates. In the case of the piano player, the pneumatics are attached directly to the keys, which are depressed when the former are operated through the tracker bar. With the organ player, the pneumatics operate either a relay with a series of contacts or a single contact. When the pneumatic closes a contact, it completes an electric circuit just as if the corresponding key had actually been depressed by hand.

The pneumatics may either be operated by suction, or by compressed air in the player. Suction or a small amount of vacuum is generally used, as it has been found to be quieter and more efficient. When compressed air is employed, the player roll box must be made air tight by drawing a glass in front of it, before the record is started. The perforations in the paper are punched by machinery from a master record that is punched out by hand directly from the music. The length of the perforation is proportional to the length of the notes to be played. The width of all perforations is uniform, and is the same or somewhat narrower than the holes in the tracker bar. The semi-automatic organ player was the simplest form to make, and was all that was available until recent years.

As early as 1907 the Welte-Mignon Company had improved an automatic piano player to the point where fairly accurate reproductions of a great pianist's playing were possible. In this improved form the player was not pumped by the feet, nor the tempo regulated manually to suit the listener's fancy. The entire operation was accomplished automatically. In my opinion these early fully automatic players, even though they were large, clumsy and heavy boxes that had to be placed in front of the piano keyboard were the most effective of any that have yet been devised. The pneumatics were larger and a greater range of dynamics was possible in such a player than from the present ones which are contained within the piano.

The Estey Organ Company, as far as I have been able to learn, were the first to develop a fully automatic player for the organ that reproduced the playing of an organist instead of being merely a reproduction of the music. Both this company and the Kimball Company made fully

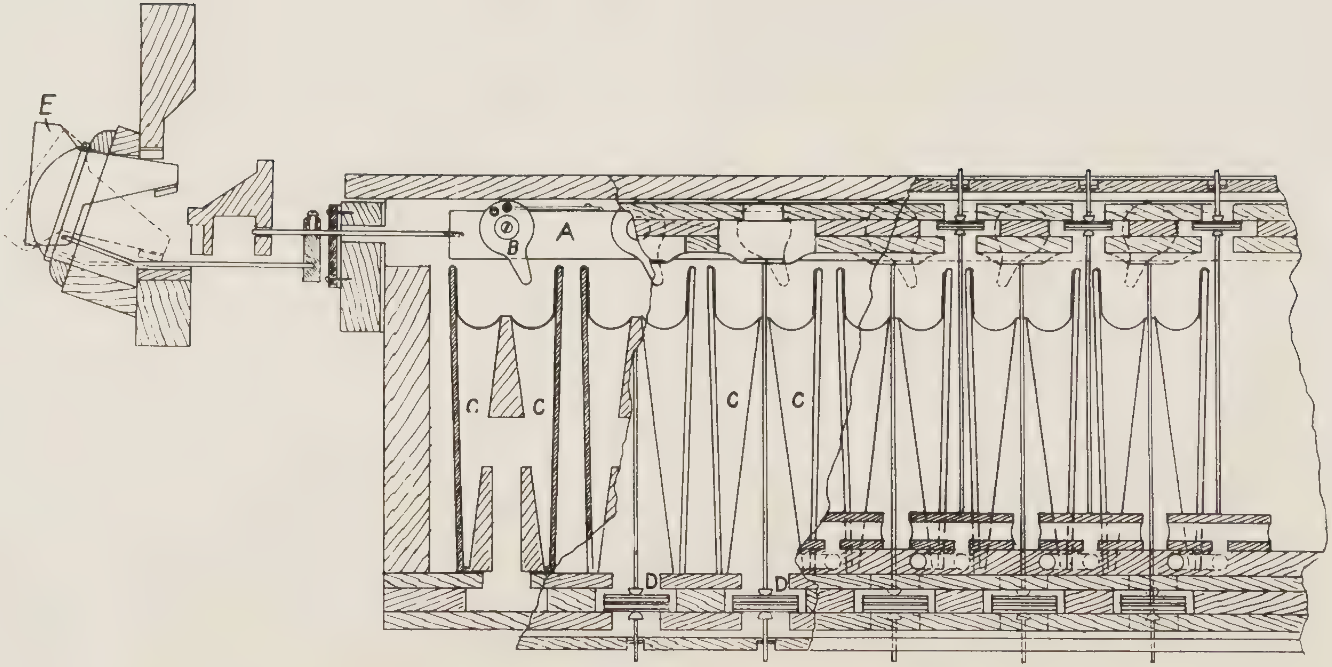


Figure 101.

The combination action used in the Pilcher organ. This is a sectional view. All the parts, except the contacts are enclosed within an air chamber. The wipers, operating on the cams, B, are made of metal, and take up very little room; the cams themselves are made of brass. The springs which hold the cams in the "on" or "off" position fit into the notches in the top of the cam, are made of phosphor bronze. This combination action requires less space than others of its type. As all the parts are enclosed in the air box, the action is quite noiseless. When the valve, D, exhausts the double pneumatics, CC, the compressed air surrounding the pneumatics, causes them to collapse and draw the trace, A, to the right or left, putting the stop off or on in accordance with the position in which the cam B has been adjusted, when the combination was set.

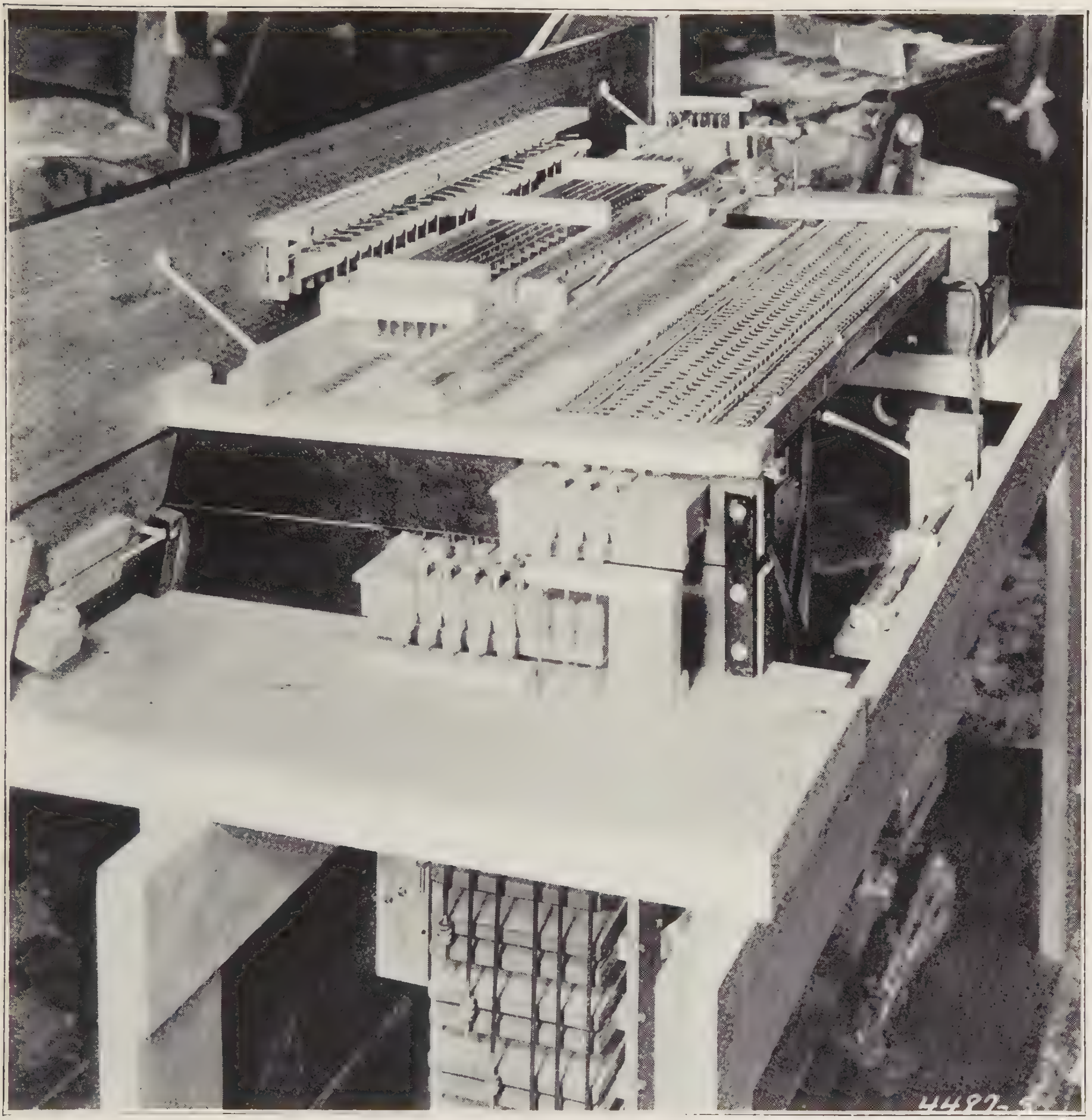


Figure 102.

Rear view of a small Moller console. The pneumatics which actuate the couplers are shown at the lower center. The key contacts are also shown.

automatic players at an early date that did not reproduce an organist's playing. The Aeolian Company in 1917 appeared with a full automatic player known as the "Duo Art" that not only played the notes the way they had been played by an organist (in other words hand recorded) but drew the proper registration, operated the expression shutters, and in fact did everything a good organist could.

At the present time, the Austin, Estey, Kimball, Moller and Skinner Companies have all perfected fully automatic players of fine accomplishment and remarkable ingenuity.

There are two ways in which these recordings are made. One, that employed by the Austin Organ Company is probably the most direct and simplest. A machine built with a series of small punches arranged in a double staggered row, each punch corresponding with a key, or stop, or expression pedal contact in the organ console used for recording purposes, is employed. When a record is being made, the organist merely plays the piece exactly as he would for a finished performance. There are absolutely no restrictions as to registration or use of manuals. Every note he plays, and the exact duration of it—every stop he draws, and every use of the expression pedal is directly transmitted by means of magnets to the series of punches. The paper is passed at a uniform speed beneath the series of punches, and is punched out, as it passes along, precisely in accordance with what the organist is playing. Every detail of the playing is accurately portrayed, including wrong notes, and other undesirable features, as well as all the good qualities. The only difficulty with this system is its too faithful reproduction of the organist's playing. It has the great advantage that the record may be heard within a moment after it is cut, and if the organist is not satisfied, he can make a new one.

The more usual method of producing fully automatic records is to employ a recording machine, with a series of ruling pens. In this case, the paper is not punched out as the piece is played, but every note the organist sounds and all other matters are accurately recorded on a moving sheet of paper. The paper moves usually at considerably higher speed than the finished record so that small inaccuracies in transcribing are overcome as such errors are reduced when the master record is punched out. From the series of lines on the master sheet, corrections for wrong notes can be made before the holes are actually punched. Also when the records are punched directly from the playing, wrong notes may be corrected by covering the holes wrongly cut and cutting in the correct holes by hand. In either case an accurate organist is an advantage, if there be such an animal outside of Mr. Lynnwood Farnam.

It is unfortunate that each builder uses his own scale and width

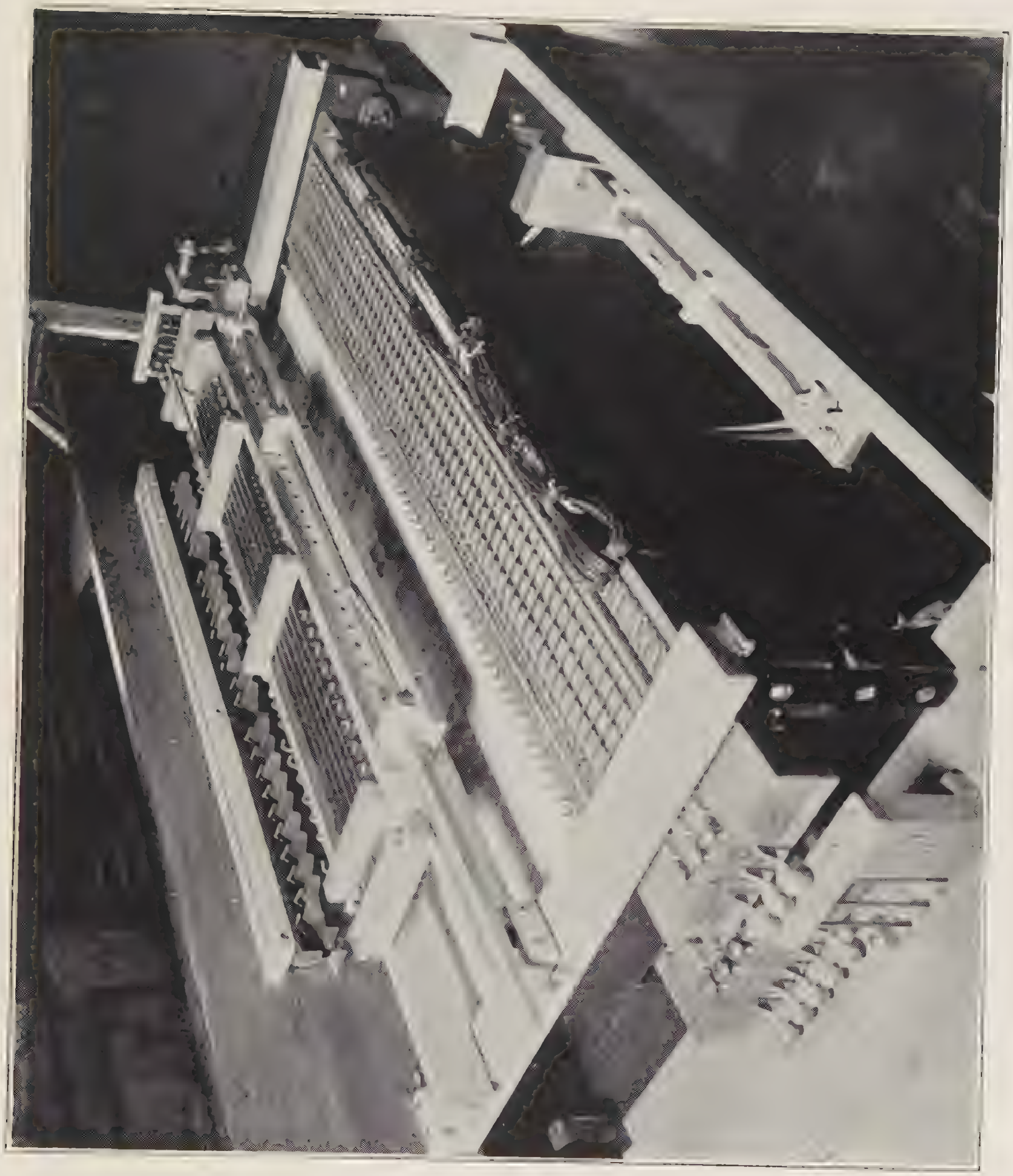


Figure 103.
A closer view of the same Moller console shown in Figure 102.

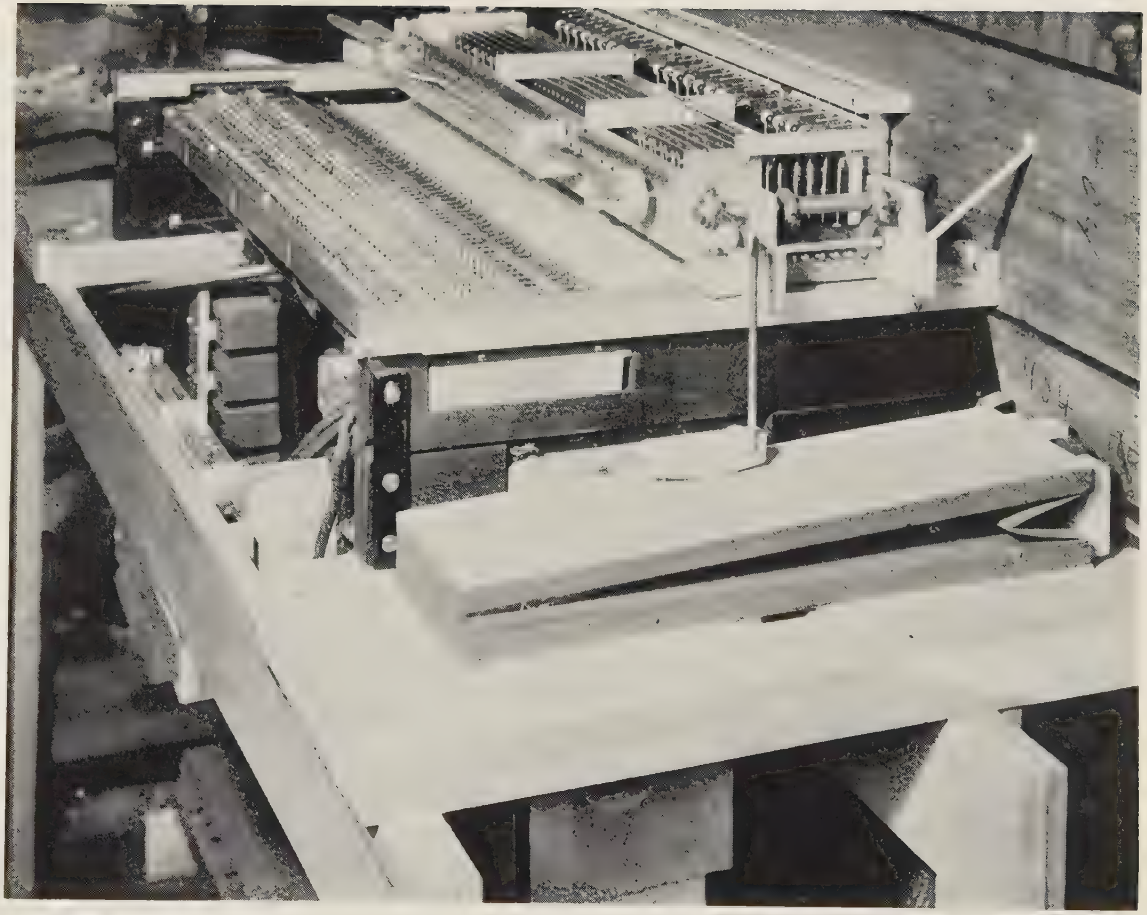


Figure 104.

A view of the combination action of a small Moller console. The large pneumatic in the foreground operates the roller shown above that in turn catches hold of the particular trigger that corresponds to the piston depressed, thereby drawing the trace forward, and operating in a similar manner to that described for the Austin combination action.

of tracker bar so that one builder's records will not fit any other. Tracker bars vary in width from nearly two feet, containing about two hundred and forty holes, as in the Austin player, to the standard width of a piano player roll. In the Austin system the three manuals may be played absolutely independently, and the pedals as well. In this case, for the most part, one hole performs only one operation. In the case of several of the other players, each hole is used for a variety of purposes at different times, for example, the same hole may be made to sound a note, draw a stop or work the expression shutters. This is accomplished by means of a series of switches, and the mechanism is necessarily more complicated than with the Austin system. However, when a very wide tracker bar is employed, compensation must be made for swelling and shrinking of the paper because of dampness or dryness. The holes in the tracker bar will not accurately fit the holes in the paper otherwise. The wide Austin tracker bar is made in five sections. The Aeolian Company employs a smiliar bar. The two outside sections on either side of the center will spread out or draw in by means of a pneumatic controlled by a series of holes in the paper. Two such series of holes are provided that run continuously throughout all Austin records, which serve to keep the paper in the right position on the tracker bar, and to cause the tracker bar to adjust its width to correspond precisely with the holes in the paper, no matter how dry or how damp the paper may be.

An automatic tracking device must necessarily be provided, with the usual players, as the space between the holes is so small that slight movement of the paper as it passes over the tracker bar, from one side or the other would cause trouble. This was one of the most serious obstacles to overcome in producing a satisfactory and reliable organ player. It has been solved successfully.

Some of the builders contend that inasmuch as perhaps ninety-five per cent of the world's best music has been written for other instruments than the organ, it is more important to make good orchestral and other transcriptions for the automatic player than merely to record faithfully the playing of a good organist, who has, after all, only two hands and two feet. Accordingly, the Skinner Organ Company and the Moller Organ Company have made numerous records from the orchestral scores, not confining their efforts to the capabilities of any organist. Such recordings go far beyond anything heretofore possible and they indeed give the automatic player a new reason for being. The Moller player, for example, is capable of playing six independent tonal lines at the same time, something manifestly impossible for any organist and feasible only with an orchestra.

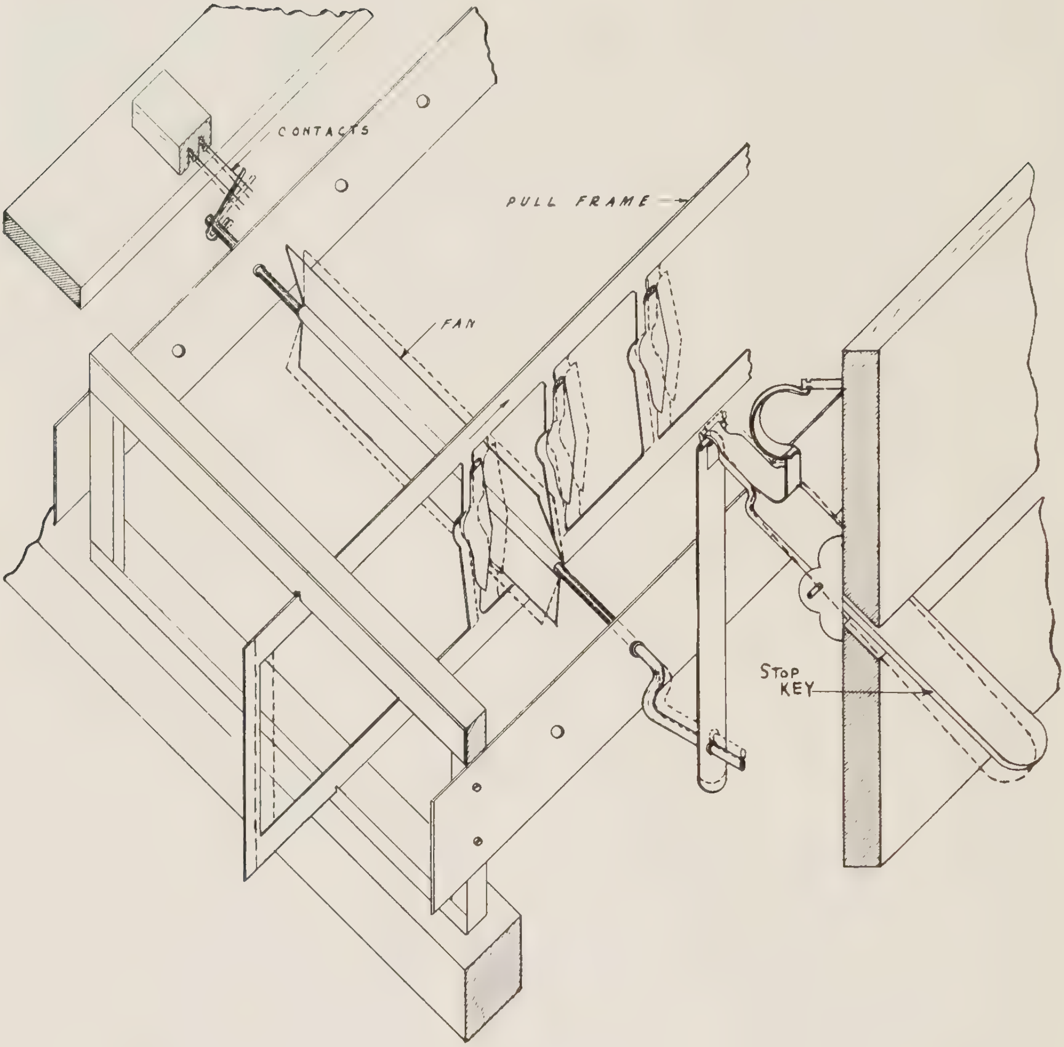


Figure 105.

A perspective view of a unit of the stop key action showing the application of the combination action to a single stop key. It will be noted that the stop key actuates a fan, which in turn may be actuated by the pull frame. Geo. Kilgen & Sons.

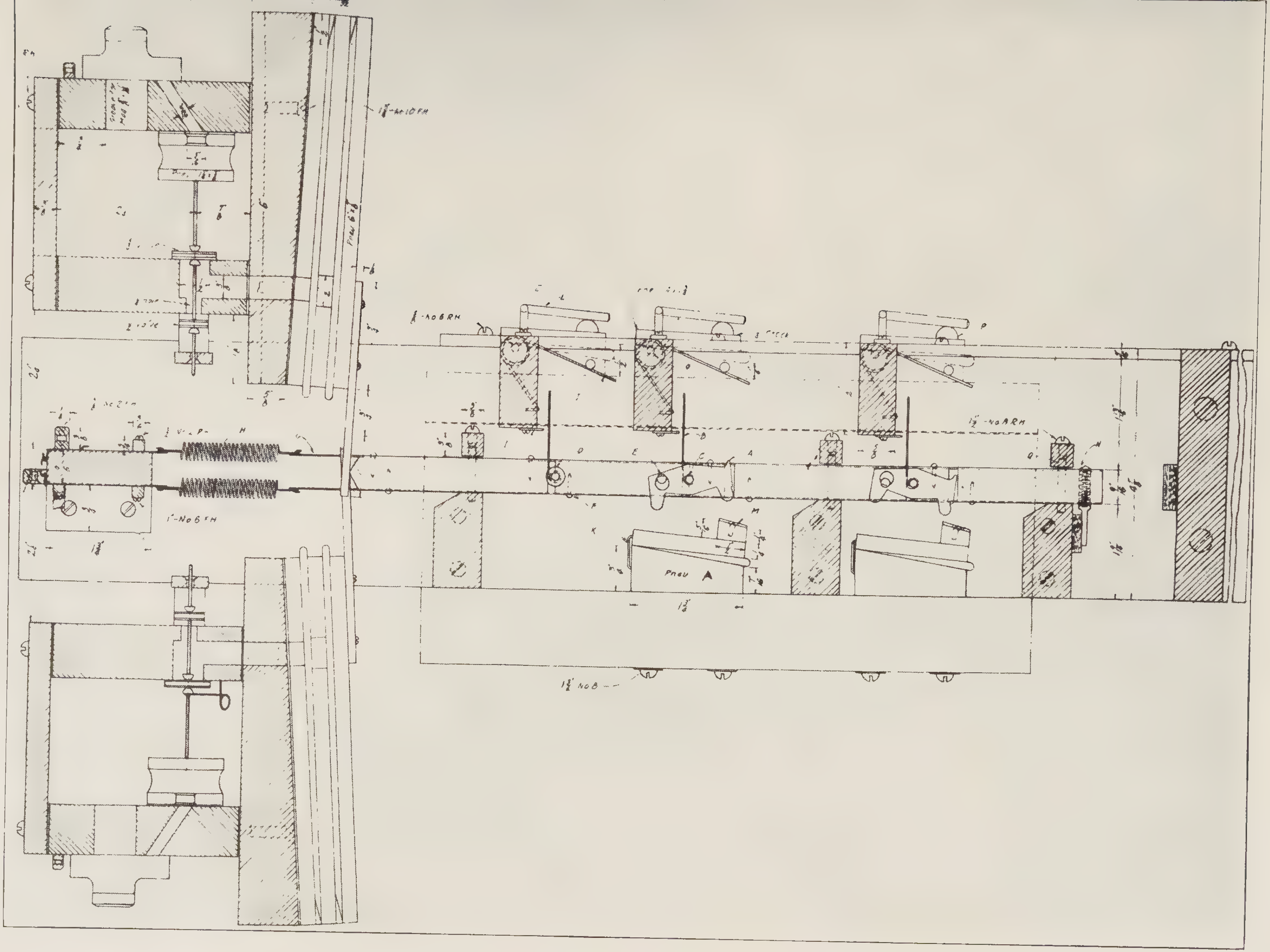


Figure 106.

The Kimball remote control combination action. This mechanism is too bulky to be placed in the console, and is only used on very large organs. It is materially more costly to build than the simpler forms shown for Austin and Moller. The Pneumatic A set the cams above in either "on" or "off" position when the setter piston is operated. To the cams are attached a contact wire that will either make or not make a contact, in accordance with the position in which the cam is set, when the trace is drawn by the pneumatics shown at the left. The stop controls in the console are then operated by individual solenoid magnets.

Such modern developments and improvements make the automatic player a truly artistic instrument, and afford a real contribution to the possibilities of the modern organ.

Manifestly, to get maximum results from such recording, an organ is required with an abundance of orchestral coloring. The design of a suitable organ for the player is considered in some detail in our chapter on Specific Examples of Good Tonal Design, under residence organs.

The writer personally installed an Austin automatic player in his residence organ, hence he feels well versed in player mechanisms, but he believes that little profit would accrue to the interested amateur to describe any of the player mechanisms more fully. Even if one were made by an amateur, records would not be available, which, after all, is the important part of any successful organ player. A good library of records is a costly and difficult undertaking for each builder, and if they could be made interchangeable between players of various makes, much expense and duplication of effort might be saved.

Though the automatic organ player is one of the most complicated and in many ways the highest development of "Canned" music, organists need not fear to lose their occupations because of such devices. People will always want the human element in music, even if that element contains a percentage of human fallibility. Possibly this quality is the one that makes "hand" playing always more interesting, no matter how perfect the reproduction may be.

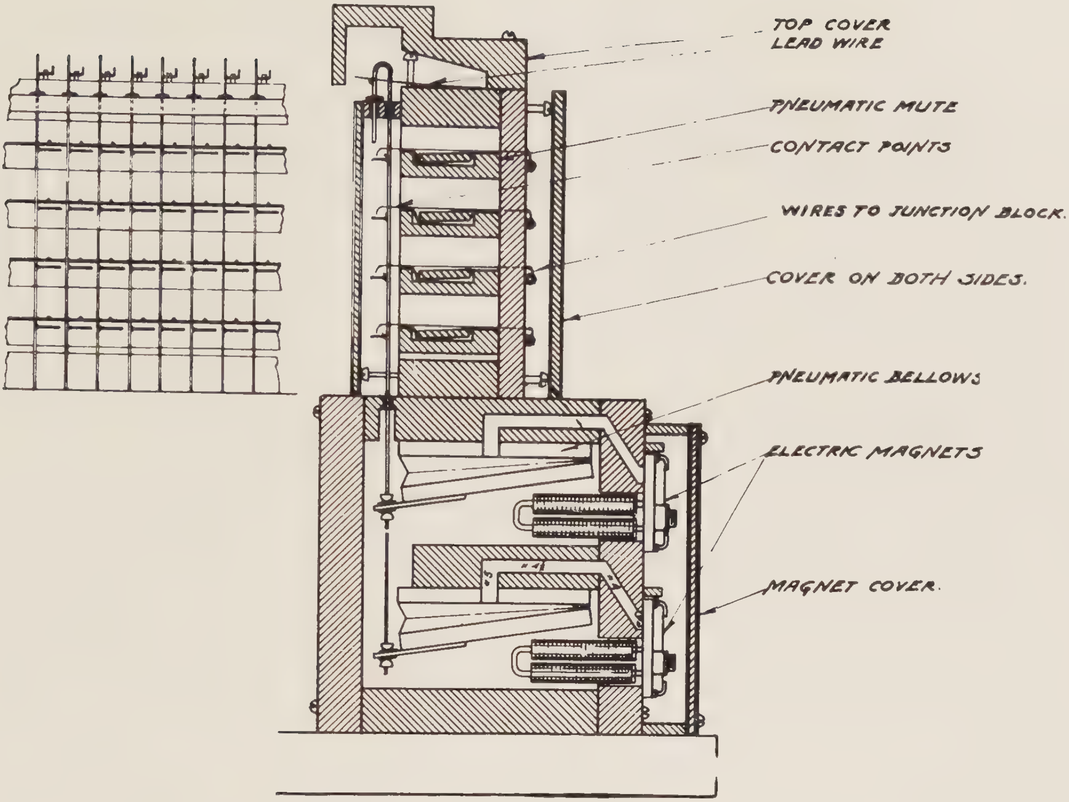


Figure 107.

Sectional view of the electro-pneumatic relay used by the Hillgreen, Lane & Co. The operation is similar to that described for Figure 109.

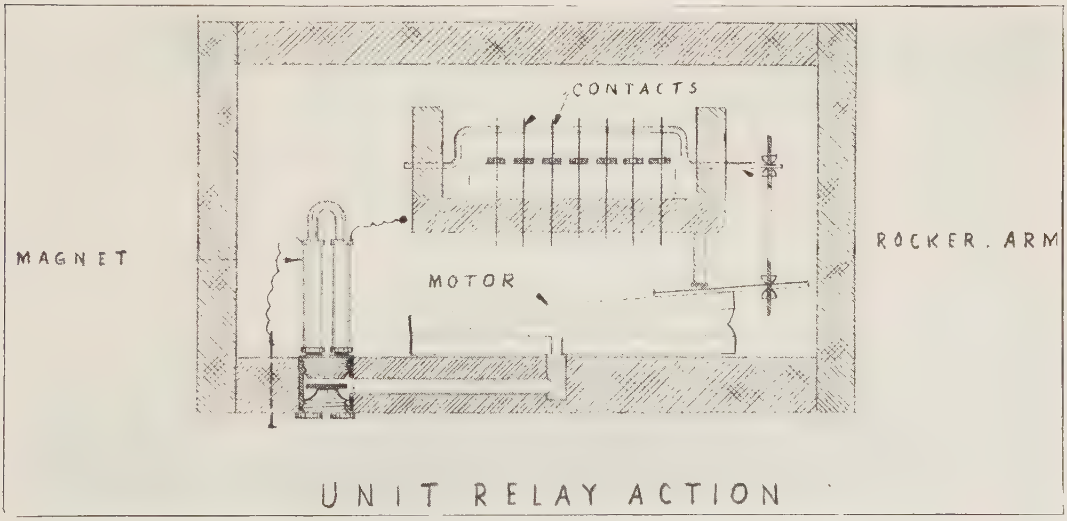


Figure 108.

The Kilgen relay action.

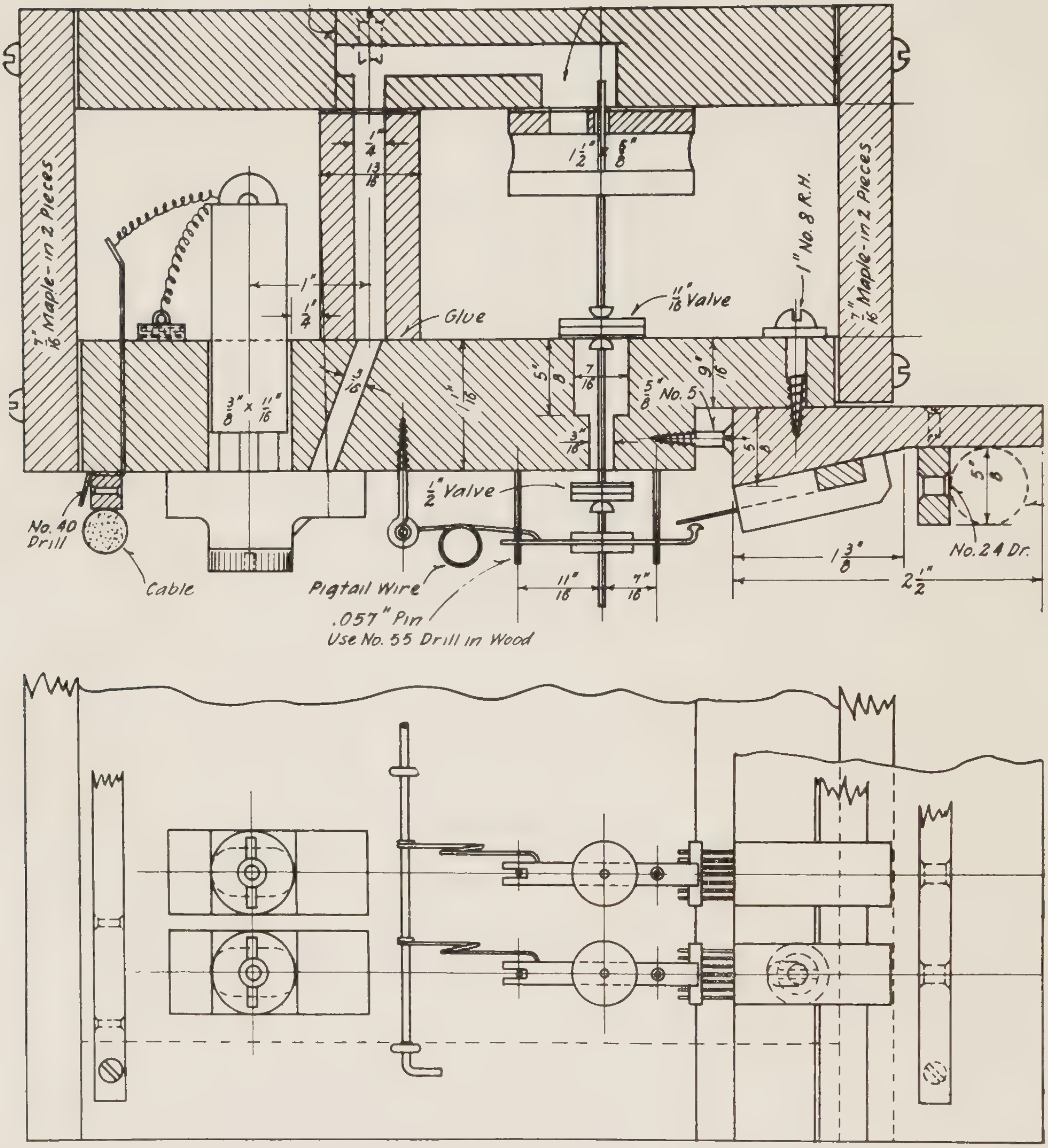


Figure 109.

Sectional and bottom views of the Kimball electro-pneumatic relay. Whenever more contacts are required than can be placed directly under the keys themselves a relay mechanism of some sort is required to give additional contacts. Referring to the upper drawing: the key contact operates the magnet which in turn exhausts the square pneumatic causing the wire attached to it to draw the bus bar against the series of contacts. This same mechanism may be employed for a much larger number of contacts than are here shown. In which case the contact blocks would have to be spaced farther apart.

CHAPTER 21.

SUGGESTIONS FOR PROSPECTIVE PURCHASERS OF ORGANS

THE experience which the author has had for the past several years in advising committees in the purchase of organs has proved to him that such committees are nearly always at a disadvantage in making a satisfactory choice. The purchase of an organ is usually an unique experience; it happens only once in a life time. Unlike purchasing an automobile or a suit of clothes, or even a new house, with which nearly every one is at least familiar, the selection of an organ must be approached with no previous experience as a guide.

The customary selection of an organ committee, made by nearly all churches, consists of two or three of the leading business men in the church, one of whom is usually the chairman of the building committee (if a new church); the pastor and the chairman of the Ladies Aid Society; and probably the organist, if the church happens to have the latter. Such a committee frequently has no one thoroughly competent to advise it. Organists, as a rule, know surprisingly little concerning the instruments they play, either mechanically or from the standpoint of tonal design, with a few happy and notable exceptions. Hence their advice should not always be followed.

To increase this knowledge among organists and interested laymen has been the chief purpose of this book. Congregations nearly always employ a competent architect to design and supervise construction of their buildings. It would simplify matters greatly for those interested in the purchase of an organ, were they able to go to a disinterested adviser, and get just the vital information necessary to make sure they were doing the right thing.

Unfortunately, the majority of so-called organ architects are either incompetent, or have an axe to grind of some sort, or may actually be dishonest in trying to collect a commission from the church who employs them, (a perfectly legitimate practice if the fee is commensurate with the services rendered) and also another fee from the builder to whom the contract is awarded. Organ builders have grown to distruct organ architects and to consider them unnecessary and a nuisance generally. This is to be regretted, as a competent and honest adviser may make himself of great advantage and assistance to both the church and the builder.

On the other hand, it happens that not all builders have representatives competent both to sell organs and to design them scientifically to suit the building, the acoustics, and the purpose most in mind. Here is

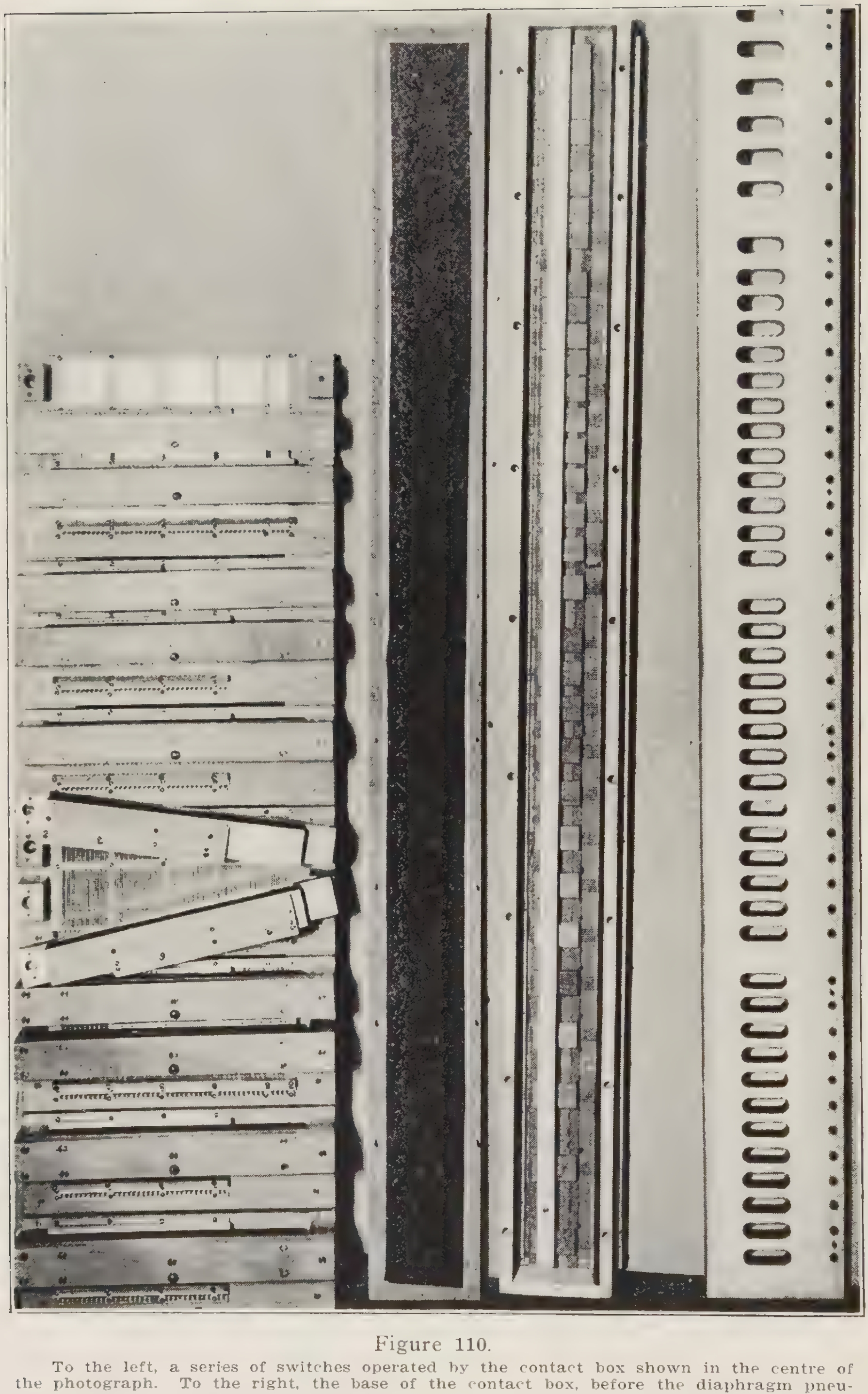


Figure 110.

To the left, a series of switches operated by the contact box shown in the centre of the photograph. To the right, the base of the contact box, before the diaphragm pneumatics with their contact blocks have been placed in position. This contact box is shown in position and in sectional view in Figure 78.

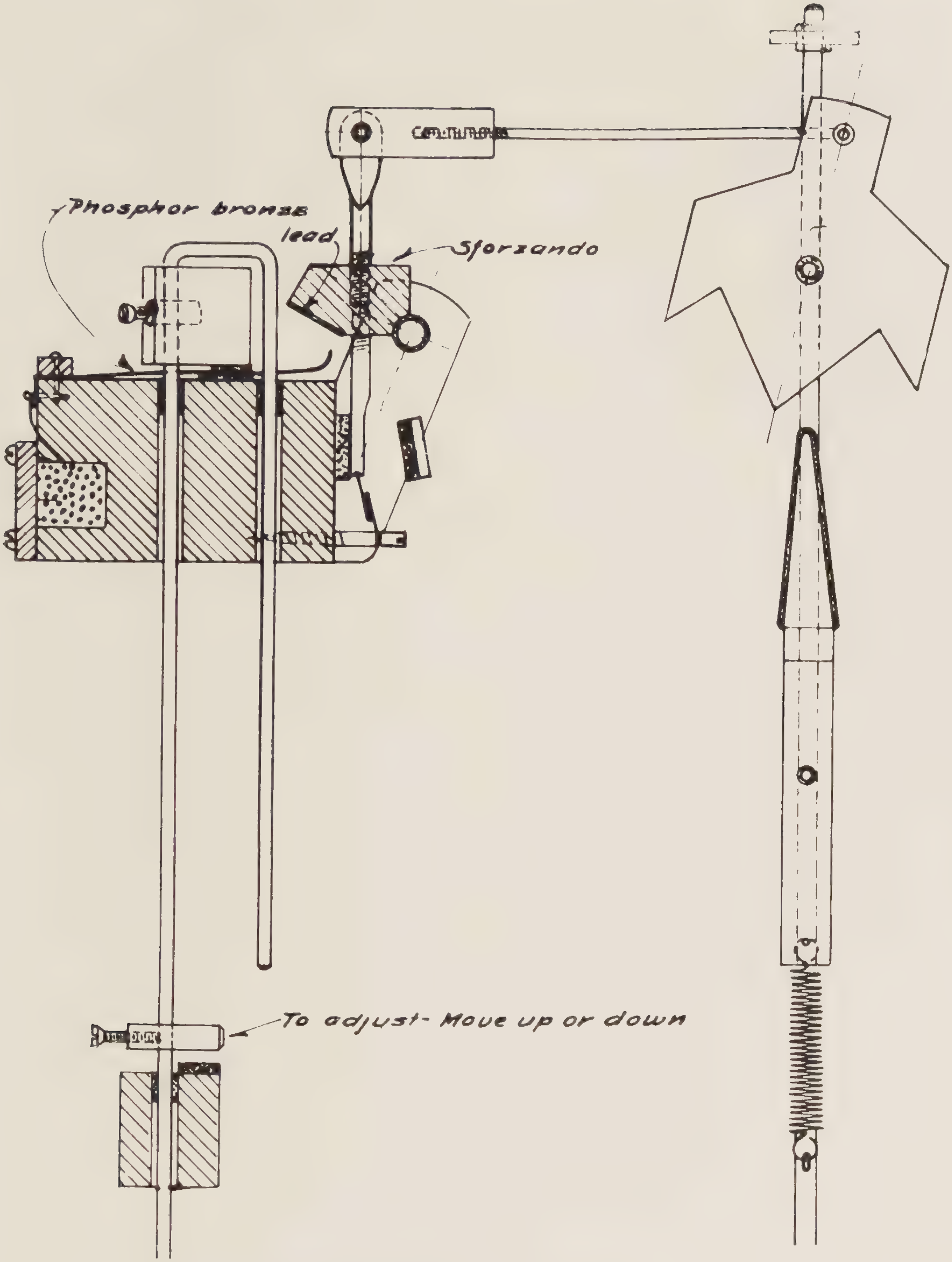


Figure 111.

On the right is shown the mechanism, whose principle is the same in all reversible actions, used for Great to Pedal couplers, Sforzando pedals, etc. The pedal actuates the pointed rod, which is pivoted and made to assume its normal position by the coil spring. Each time this rod is moved, it causes the mechanism at the top of the drawing to reverse its position.

where a disinterested adviser may be invaluable. Assuming, however, that such a person is not available to the committee, I am endeavoring to furnish them with the following suggestions that have been found to be of advantage.

When an amount of money not in excess of twenty thousand dollars is available a different procedure should be followed from the one I suggest when a greater amount than this is provided. A fair way to arrive at a reasonable amount to spend for an organ is to divide the cost of the church building by ten. Ten per cent of the cost of the church itself usually is a fair average price for a suitable organ. A minimum allowance should be one pipe in the organ for each seat in the church, though double or triple this allowance is better. If a church costs one hundred thousand dollars, an organ of minimum requirements may be bought for eight thousand dollars and it would be unjustifiable, except in rare instances, to spend more than fifteen thousand dollars; a fair price would be a little less than mid-way between these two figures. When a church costs more or less than suggested above, the allotment of funds for the organ should be correspondingly increased or decreased.

As a general rule, the organ is the last thing to be considered when a new church is under construction and it is frequently found that so much of the available money is already spent that there is no adequate provision for the organ. In such cases, preparations may be made in the console for future additions when more money can be obtained to complete the plan.

It is a poor practice, but one frequently followed, for the organ committee to write a number of organ builders, stating that it has a given amount of money to spend for an organ. The builder is then invited to submit a specification which he will build for this amount. This inevitably results in the committee receiving a different specification from each builder, some good and some bad. It is usually impossible for the committee to analyse the bids received or to make comparisons in price per stop; and by the time the representative of each builder has called and stated that his company undoubtedly builds the best organ, at least for the money, the committee begins to realise that it is out over its head, and needs some disinterested advice. I have been called in on numerous occasions of the sort. I have found it more helpful to proceed from the first along different lines.

The organ committee should itself send the builders a carefully considered specification that will cost approximately the amount they desire to spend. The difficulty here lies in procuring such a scheme. Nearly all organists think they can draw a good specification for an organ. In reality few of them can. For this reason I do not suggest that

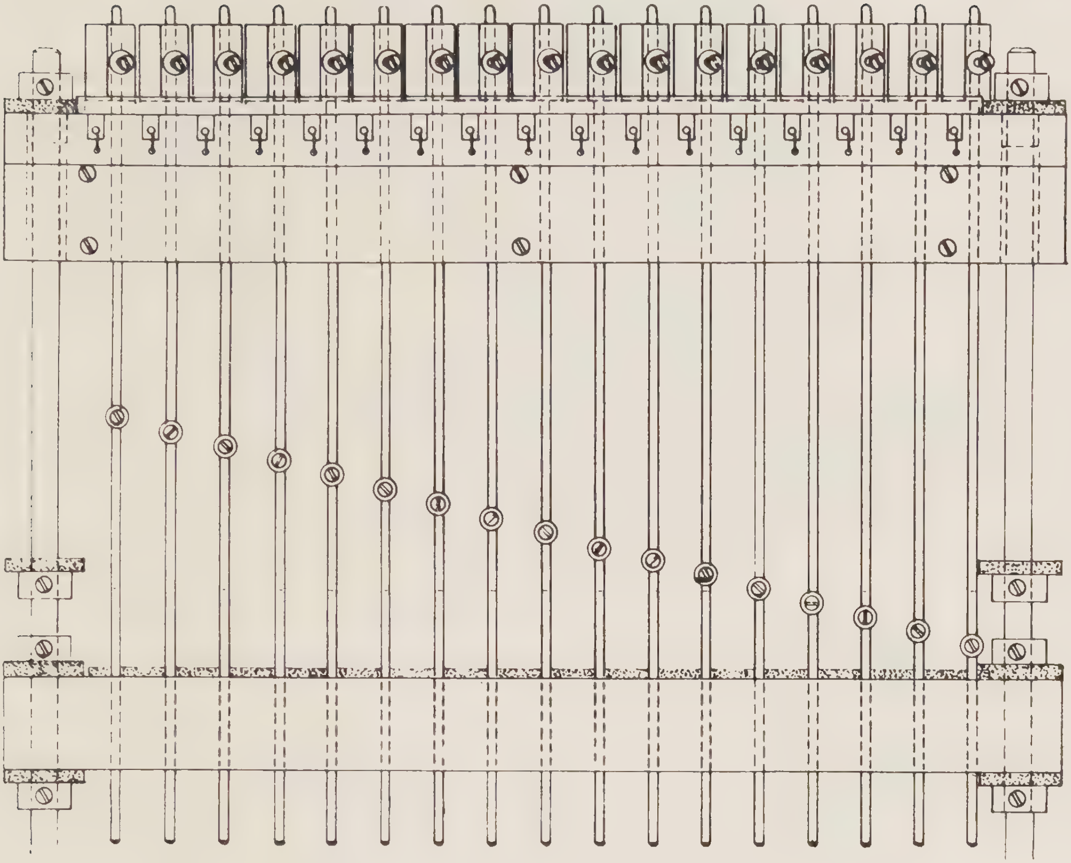


Figure 112.

A form of crescendo pedal mechanism built by Hillgreen, Lane & Company. When the pedal is pushed open, it raises the broad wood strip at the bottom of the drawing that progressively engages the set screws on the series of wires. Each wire, upon being raised makes a contact with a stop or coupler. By moving the position of the set screws, the order in which the stops come on can be readily adjusted to suit the organist. A large organ would obviously have many more set screws and wires than shown in the above drawing.

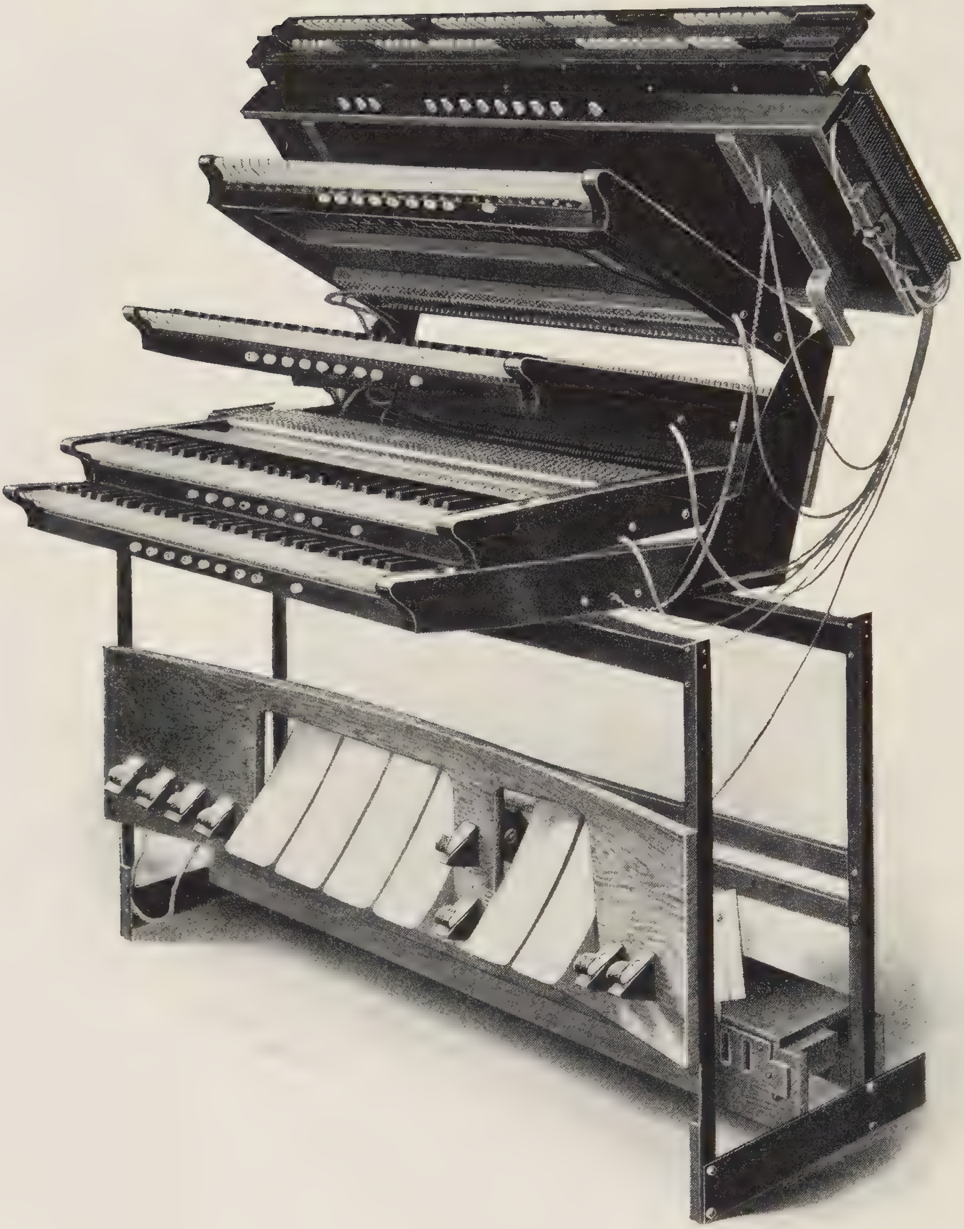


Figure 113.

A standard Austin console, with the case work removed. All of the moving parts are placed on a steel frame, entirely independent of the outer case. This keeps the parts in perfect alignment at all times. It is usual with all modern consoles, as in the view shown above, to be able to raise the manual keyboards up, one after another, which affords ready access to the key contacts for adjustment. The keyboards are hinged at their back ends for this purpose, with the cables made a little longer to permit of this.

an organist be permitted to draw the scheme unless his knowledge and experience is unquestionable.

In the chapter on Specific Examples of good Tonal Design, I have there listed a number of schemes of various sizes (of tested and proved merit) which cost from a few thousand to twenty-five or thirty thousand dollars. When more than this amount is available I suggest that the organ matter be placed in the hands of one of our recognized leading builders at the very start, and that his advice be accepted implicitly. This course cannot be so advantageously followed when the more usual appropriation for an organ is made, as in such cases it is most important that the maximum value be received for each dollar spent.

If the committee will bear in mind that an organ costs from four to seven hundred dollars for each set of pipes, depending on the builder selected, with a fair average, perhaps, of five hundred dollars, they may multiply the number of sets of pipes listed in the examples given, by five hundred dollars, to arrive at an approximate cost of any of those schemes. Then selecting a specification likely to cost the amount the church desires to spend, the identical scheme should be submitted to various builders and in that manner a direct comparison of the prices of each builder may be readily obtained.

When this has been done, the committee should next hear representative organs (of the approximate size under consideration) of each builder. In this manner, a much more intelligent opinion may be formed as to whether the committee feels it advisable to pay ten, fifteen or fifty per cent more for A's organ as compared with B's or C's. I have known prices to vary as much as one hundred per cent on the same specification, so committees need not be surprised at wide deviations in price.

It must again be pointed out that if the same specification was built by a dozen different builders, a dozen different organs would result, ranging in quality from excellent to quite the reverse. We may assume, to take an example with which all are familiar, that the general specifications of a Buick automobile are the same, both with regard to wheel base, motor size, etc., as a Packard. Yet no one would expect to get Packard quality for the price of a Buick. People can see this readily in respect to automobiles, with which they are familiar, but frequently fail to see this with organs, concerning which they know much less.

For the comfort of those committees with limited funds, it should be noted that many of the lower priced builders give excellent value, the same as many lower priced automobiles will perform in general like those of much higher price. Certain refinements and subtleties are the chief distinguishing features of the higher priced product in either case.

Having settled on a builder, he should be informed of all particulars with regard to size of church, its general acoustical conditions, type of service, whether liturgical or otherwise, and his suggestions should be followed as to placing the organ and the openings required. If he has then any real suggestions to make as to modifying the scheme slightly to suit his factory methods, whereby it is evident the church and perhaps the builder will benefit, such suggestions may be carefully considered. Nothing but confusion will result in listening to such suggestions before the builder is actually decided upon. In such a case the whole purpose of asking each builder to bid on an identical scheme would be defeated, and the same uncertainty would exist as with the customary procedure.

SUGGESTIONS AS TO ORGAN CASES AND GRILLES

It is also important for the committee to decide early in the proceedings whether it is wise to spend at least eight to ten per cent of the cost of the organ for a case. From this minimum allowance, cases may cost as much as the organ itself. When funds are limited it seems much wiser to put all the money into the organ and (instead of attempting to purchase a makeshift case) to use some form of grille.

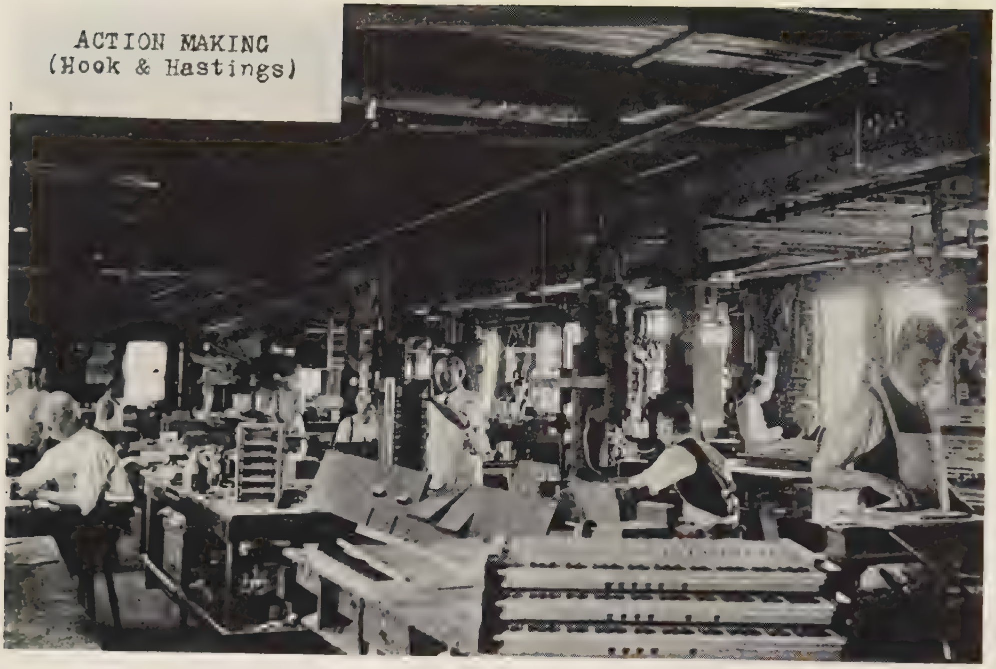
Such a practice has come into general favor the past ten years, due in part no doubt to reasons of economy, but more to the fact that organs are now usually placed in chambers, where no case work is necessary. Such treatment of the exterior of the organ is probably better than the typical organ builder's front, or perhaps what might more accurately be called the organ committees' front. When so little money is allotted for a case that it consists merely of some dummy pipes and some cylinders behind them, which look like tomato cans (to create the effect of additional pipes), even this expenditure is unwise; rather no attempt at an organ case than such a one. The money would be far more usefully spent for additional pipes in the organ.

When ample funds are on hand to purchase a suitable case, it is possible to enhance greatly the beauty of that portion of the church where the organ is located, if it is treated architecturally in a congruous manner with the church interior. Best results will be obtained in this event, by employing the architect of the church to design something suitable and appropriate.

This book contains photographs of several outstanding organ cases. They are included both because of their inherent beauty and also as suggestions for the design of others. The author feels competent to offer only these general suggestions concerning the design of casework. With full appreciation of the value of beautiful organ fronts, he nevertheless feels that grilles are preferable to a cheap and ugly conglomeration of display pipes.

One more very important matter should be mentioned. Those who have read the chapter on Voicing of Organ Pipes will know the extreme importance I place on the final finishing of every organ. Readers are referred to this chapter for details as to what this finishing comprises. It is the most difficult matter for builders to supervise, as they are generally dependent on the finisher they employ, without any factory supervision. A church should in all possible cases secure the services of an organist or other person qualified to judge, to pass on the final finishing. This will be of advantage both to the church and the builder. They will both have a better organ. The builder should be glad to cooperate and thus have the assurance that this vital matter has been properly carried out.

Finally, it is a pleasure to record after long experience with organ builders, that honest and conscientious builders are in the large majority, and that they strive to do the right thing and frequently do more than merely fulfill their agreements.


ACTION MAKING
(Hook & Hastings)

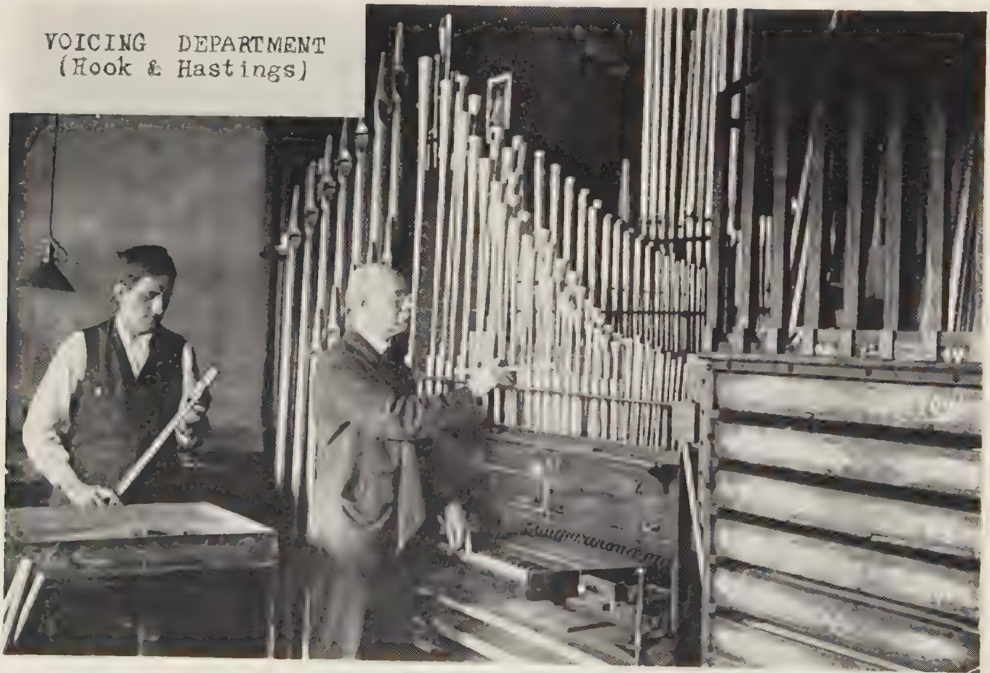

VOICING DEPARTMENT
(Hook & Hastings)

Plate XXX.

CONCLUDING REMARKS

IN the preceding pages, specific mention, accompanied by drawings, is made of perhaps a dozen builders, who for one reason or another have been selected by the author as furnishing good examples of modern organ action of various general types. As stated in the introduction, it would be unprofitable from the standpoint of information and would also require hundreds of additional pages to illustrate and mention specifically the work of every American organ builder.

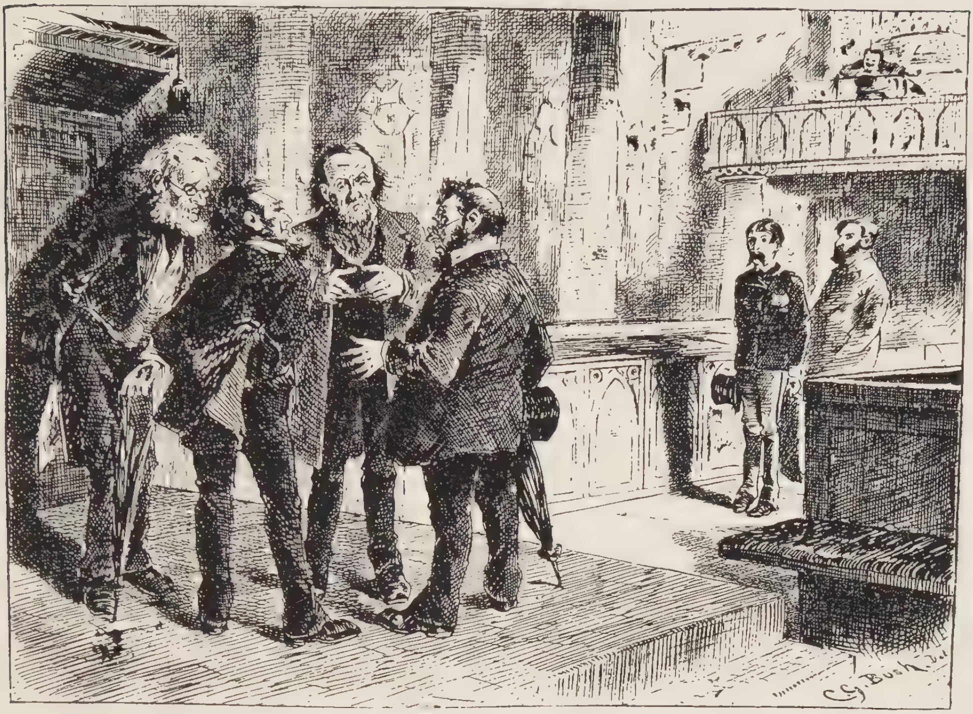
Nothing is farther from the author's intention than purposely to have slighted or ignored the work of any builder. Because of the physical impossibility of giving every builder equal space and attention, the reader should not gain the impression that the work of those builders apparently neglected, is necessarily inferior to those included. Indeed, in some instances their output may actually be superior to some of the builders specifically mentioned. The author was unable to obtain drawings or other data from some builders which he would gladly have included.

In all fairness, therefore, the following practically complete list of American organ builders is appended, whose work has either received only casual mention in these pages, or none whatever. If the reader who is interested in the work of any of these builders will ascertain the general type of windchest and console action such builder employs, he will be able (by reference to the various classifications of organ action in this work) to obtain a very good idea as to that builder's mode of construction.

Those builders who have had frequent mention in this work are not included in the following list, now given, with apologies to those whose work cannot be more specifically noted than in this manner. These latter include several names of enviable reputation, extending back for many decades, as well as newcomers in the field. (The names are arranged alphabetically.)

Artcraft Organ Co., Santa Monica, Cal.
Bartholomay & Son, F. A., Philadelphia, Pa.
Barton Organ Co., Oshkosh, Wis.
Buhl Organ Co., Utica, N. Y.
Frazee Organ Co., Everett (Boston), Mass.
Geneva Organ Co., Geneva, Ill.
Gottfried Co., Erie, Pa.
Hall Organ Co., West Haven, Conn.
Hinners Organ Co., Pekin, Ill.

Hook & Hastings Co., Kendall Green, Mass.
Legge Organ Co., Ltd., Toronto, Ontario, Canada.
Lewis & Hitchcock, Inc., Washington, D. C.
Marr & Colton Co., Warsaw, N. Y.
Odell & Co., J. H. & C. S., New York, N. Y.
Page Organ Co., Lima, O.
Reuter Organ Co., Lawrence, Kan.
Rochester Organ Co., Rochester, N. Y.
Schantz, A. J., & Sons, Orrville, O.
Tellers-Kent Organ Co., Erie, Pa.
United States Organ Co., Crum Lynne, Pa.
Votteler-Holtkamp-Sparling Organ Co., Cleveland, O.
Wangerin Organ Co., Milwaukee, Wis.
Welte-Tripp Organ Co., Sound Beach, Conn.
Wurlitzer Co., The Rudolph, North Tonawanda, N. Y.



"WAITING FOR THE VERDICT"
A Church "Music Committee" in session

Compliments of.
Hilborne L. Roosevelt

Figure 114.

One of the greatest American organ builders of the latter part of the nineteenth century sent this cartoon to his friends. Church organ committees no longer look like these gentlemen, but may have to argue just as hard. Meanwhile, the organ builder would doubtless be shaking in his boots as he is in the above, if he still wore boots.

INDEX

PAGE
Aeolian Co., The 42, 125, 185, 200, 287, 308
Aeoline—Soft String 56
Airplane Effect 136
American Organist, The 9, 29, 72, 86, 110, 126, 139, 145
Anemometer 24
Archimedes 13
Arcing at Contact Points 245
Armature Disc, Defined 237, 240
  Weight of 248
Artcraft Organ Co. 334
Atlantic City Auditorium Organ 40, 74, 76, 189, 195
Atlantic City Ball Room Organ 232, 167, 182
Atlantic City High School Organ 48, 93, 182
Auditorium, Cleveland, Console 151
Auditorium, Washington, D. C. 138
Audsley, Geo. A. "The Art of Organ Building" 7, 12, 21, 31, 36, 46, 60, 64, 86, 92, 111, 121, 123, 211, 230
Auer, Leopold 127
Augustine, St. 13
Augmented Pedal 191, 192
Austin, Basil G. 58, 250
Austin, John T. 143, 167, 250
Austin Organ Company......17, 28, 71, 85, 114, 116, 119, 120, 155, 199, 251 253, 254, 255, 257, 297, 298, 327
Auxiliary or Primary Box........263, 274
Author's Scheme 178
Auto Horn 136
Automatic Players 308, 312
Avery 46

Bach, Johann Sebastian ..15, 104, 147, 148
Barker, Charles Spachman 16, 214
Barker, Lever, ...214, 215, 237
  Application of, to electro-pneumatic 217
Barrows, Robert Y. 53
Bartholomay & Son., F. A. 334
Barton Organ Co. 334
Bassoon, Orchestral 73
Beater Tremulant 129
Bedart, Gabriel 216
Bellows Boy 19
Bellows 18, 28
Bellows, Concussion 28
Bernhard 13
Best, W. T. 216
Bishop, J. C. 223
Block of Reed Pipes 38, 61
Body of Pipe 32, 35
Bombarde 73
Bottom Boards 263, 266
Bonavia—Hunt. Rev. Noel
  "The Church Organ" 9, 44, 46, 48, 50, 65, 66, 86, 96
Bourdon—Sub Bass 54
Bourdon-Gedeckt, Polyphoned 53

PAGE
Bridge (Builder England) 46
Bridges, Harmonic 55
Bryceson Brothers 236
Buhl Organ Co. 334
Buhrman, T. Scott, Editor "American Organist" 9, 139, 145, 233
Burnishing of Pipes 32
Burnishing Tool for Reeds 66
Byfield 46

Carruthers, Joseph J. 48, 81, 84
Carthage 12
Casavant Freres, ...218, 266, 236, 237, 249, 288, 290, 292, 294
Casework 330
Casting Box 32
Cathedral, Garden City, L. I. 236
Cathedral, Liverpool 74, 76, 79, 103, 171, 175
Cathedral, Notre Dame, Paris 26
Cathedral, Ottawa, Canada 292, 294
Cathedrale de St. Hyacinthe 292
Cathedral, St. John the Divine........ 10
Cathedral, St. Patrick's, New York Frontispiece, 159
Cathedral, St. Paul's, London.....74, 216
Cathedral, St. Paul's, Buffalo......... 69
Cathedral Tone 145
Cathedral, Westminster Catholic, London 76
Cathedral, Winchester, England....... 14
Cavaille-Coll, Aristide......16, 61, 128, 139 150, 215, 292
Celesta 137
Celeste effect 56, 128
Chapel of the Intercession, New York 17
Chicago Auditorium 112
Chimes 133
Chinese Block 136
Christian, Palmer 234
Chorus Reeds 61, 64, 148
Church, Fourth Congregational, Hartford 250
Church, Holy Communion, New York 87, 231
Church, Roman Catholic............. 16
Church, St. James the Less, Philadelphia 29
Church, St. George's, New York City..155
Church, St. Marks, Philadelphia ...48, 93
Church, St. Patricks, Montreal, ..290, 292
Church, Tyne Dock, England 46, 48
Circuit, Electric 244, 245
  Necesity for Soldering Joints in,....247
Clarabella 45, 55
Clarinets (Reeds) 61, 63, 67, 96
Clark, William Horatio 226
Classic Type of Organs 141, 148
Classification of Flue Pipes 44
Clough & Warren Co. 250
Combination Actions, ...306, 307
  Austin 309
  Hillgreen Lane & Co. 310

PAGE
  Pilcher Sons 312
  Moller 316
  Kilgen & Sons 318
  Remote Control 319
Combination Pistons 223, 234
Combination Pedals 223
Compass of Chimes 133
    of Harp 135
    of Manuals 230
    of Pedals 230
Compton, John 74, 102, 167, 170, 187
Construction of Metal Flue Pipes ..30-41
    Reed Pipes 41-56
    Wood Flue Pipes 56-69
    Diaphones 69
Contacts, Key 244
  Materials of which made 246
Contra Bassoon 73
Corno di Bassetto 73
Cornopean 65, 67
Counter-boring 276
Coupler Action (See Key contacts)
Courboin, Charles Marie...79, 113, 126, 183
Covell, William K. 161
Crescendo Pedal 223, 305
  Mechanism of, ...327
Ctesibius, (284-246 B. C.) 11, 12, 13
Cube—(Compton) 102, 169
Curvature of Reed Pipes 66
Curving Machine 66

Dampers 135
Deagan, Vibra-Harp, Chimes 132, 135
Delatre, Rev. Pére 12
Diapason, ...36, 39, 40, 44, 96
  Double Languid D. 75-77
  Foundational Type 48
  Pedal D. 45, 67, 71, 144
  Phonon D. 50, 99
  Salicional D. 67
  Schulze D. 46
  Stopped D. 54
Diapason, The Magazine 139, 144, 158
Diaphones 30, 69-71
Direct Electric Action 287
  Wicks Patent 287
Disc or Armature, defined 237, 240
  Weight of, ...248
Dom Bedos, "L'Art de Facteur
  d'Orgues" 15, 31
Doppel Floete 51
Double Touch 234
"Dual" Expression 121
Dulcianas 36, 39, 67
Duplexing 186
du Pont, Pierre S. Organ 42, 125
Duval, Dr. Sallust 292

Echo—Viol 56
Electro-Pneumatic Console 225
Electro-Pneumatic Action,
  General description 236
  Early Forms 238

PAGE
Elliot, Robert P. 79, 250
Emmanuel Church, Boston, ...80
England (Builder) 46
English Horn (Reed) 59
Ensemble, defined 148
Erzähler 72
Erecting Room,
  Geo. Kilgen & Sons 204
  M. P. Moller, Inc. 228
Estey Organ Co. 38, 39, 304, 311
  Windchests 262, 264, 265
Expression Pedals,
  Position of, ...124
  Balanced, ...111
  Hitch down, ...111
  Austin, ...122
  Moller, ...122

Fan Blower, Rotary Electric 20
Farnam, Lynnwood 87, 113, 126
Farrand & Votey, ...237
Feeders 18
Fifteenth—or Super Octave 52
Finishing of Organs 99
First Baptist Church of Evanston 164-166
Flight 16
Flue Pipes 30
Flutes, Ancient 11
    Flauto Amabile, Flute d'Amour,
    Flauto Dolce 56
    Flute Tone 96
Folds—Ribs 18
Foot of Pipes 32, 35
France, Organs in 16, 61
Frazee Organ Co. 334
Free Reeds, ...61
French Horn 61, 63, 65, 72, 75
French Trumpet 62, 73
Frescobaldi, ...14

Gamba, ...16, 67
Gauntlett, Dr., Inventor of the Electric
  action, ...236
Gedeckt or Stopped Flute 50
    Gross Gedeckt, ...73
Gemshorn, ...52, 67
Generators, for action current 242
Geneva Organ Co. 334
Glockenspiel, ...137
Goodhue, Bertram Grosvenor, ...17
Goodman, T. Bernard, ...169
Gottfried Company of Erie, Pa. 63, 334
Gray, ...46
Great Organ Keyboard, defined 208
Greek Church, ...14
Green, ...46
Griffin, ...46
Gubler, ...15
Guild of Former Pipe Organ Pumpers 19

Hall Organ Company 206, 334
Hardy, Maurice E. 48

PAGE
Harmonic Bridge, ...31, 99
Harmonic Corroborating Stops 86-94
Harmonics, defined 90, 91
Harmonic Flutes, ... 55
Harp, ...133
  Hammers, ...137
Harris, ... 46
Harrison, Donald 8, 145, 147
Harrison and Harrison 74
Haskell, William E. 38, 39, 73
Hawkins, Sir John 14
Heinroth, Charles 126
Helmholz, ... 39
Herbst, ... 15
Hero, ... 11
High Pressure Reeds, ... 78
Hildebrand, ... 15
Hillgreen, Lane & Co. 29, 261
  Windchest 284, 285
Hill, Norman & Beard 74
Hinners Organ Co. 334
Hook and Hastings 213, 236, 332, 334
Hope-Jones, Robert 23, 30, 50, 55, 63, 69, 70, 114, 141, 142, 143, 179, 236
Hopkins & Rimbault "The Organ" 7, 14, 30
Hutchings-Votey Organ Co. 226
Hydraulus, ...11, 12, 13

Interference, in tuning 104

Johnson & Son 213, 236
Jordan, Abraham 16, 46, 111

Key Contacts and Coupler Action 293
  Casavant 288
  Austin 297, 298
  Hillgreen, Lane & Co. 29, 303
  Kilgen & Sons 29, 301
  Kimball Co. 295
  Moller Co. 296, 300
  Operation of, ...293
Kilgen & Sons, Geo. 87, 159, 242
  Windchest Actions, ...267, 268, 269
Kimball Company, W. W. 22, 26, 48, 71, 73, 115, 118, 124, 130, 218, 232
  Windchest Actions, ...271, 276, 277
Kleine Erzahler, ... 73
Knight (of Chichester) 46
Kohler-Liebich Company 133

Languid, ...32, 33, 35
  Obtuse Bevel, Figure 11, ... 33
  Inverted, Figure 11, ... 33
Leather, use of for pipes, ... 99
Leathering of Shallots, ... 61
Leet, Leslie N. 200
Legge Organ Co., Ltd. 334
Lemare, Edwin H. 223
Lewis & Hitchcock 334
Lewis, W. & T. "Modern Organ Building" 20, 224, 259
Liberal Jewish Synagogue of London 168, 170

PAGE
Lip, Upper and Lower 35
Losh, C. Seibert, ...231
  Seven Octave Compass, ...231, 233
Low-Voltage 244

Magnets, defined 237, 238
  Hope-Jones, ...239
Magnets
  Operation of, ...241
  Winding the cores, ...243
  Parts of the Moller, ...243
  Resistance of, ...245
Mandrel, ... 32
Manual Couplers, Tracker, ...221
  Tubular 224
Marimba, ...137
Marr & Colton Co. 334
Master Swell Pedal 123
Mayland, R. H. and Son 133
Measurements, Standardization of, ...227
  of Console, ...229
Melodia or Hohl Flute, ...47, 55
Melody Touch, defined 234, 235
Melody Octave Coupler, ...234, 235
Metal Flue Pipes, Construction of 30
Metropolitan Museum of Art, N. Y.... 14
Meyrick-Roberts 171
Michel, George, ... 73
Midmer-Losh Co., Builders, 40, 68, 77, 93
Miller, George Laing "The Recent Revolution in Organ Building" 7, 50, 70, 238
Minneapolis Scheme, ...178
Mixtures, ... 86
  Chorus, ... 87
  Blending & Balance, ... 92
  Breaks in, ... 91
  Diapason Mixtures, ...93, 153
  Necessity for, ... 89
  Ripieno, ... 87
  Timbre creating, ... 87
Moller, M. P. 62, 122, 138, 207, 278, 280, 281, 282
Moitessier, French Organ Builder, ...216
Mormon Tabernacle, Salt Lake City,.. 85
Museum, George F. Harding, Chicago 14
Mutations, defined 86
Mutation Work, ... 86

Nags-Head Swell, ...111
Nicking, ...95, 98
Nicked, ...95, 98
Node, defined 96
  Nodal point, ... 96

Oboe, ...56, 64
Ocean Grove, New Jersey, ... 69
Octave, ... 52
Odell, J. S. & C. H. 287, 334
Organ Action, History of 208
Organ Architect, ...152, 323
Organ Beater, ... 13

PAGE

- Organ Design, two and three manuals, (See Tonal Design) 153
- "Organic," Greek term, ... 11
- Organum, (St. Augustine) 13
- Overtones or upper Partials, ... 90

- Pair of Organs, (Medieval) 14
- Page Organ Co. 334
- Pallet, defined 210
- Pedal Bourdon, ... 42
  - Diapason, ...52, 47
  - P. Violone, ... 49
- Pedal Couplers, Tracker 219
- Pedal Keyboard, ...131
  - Location of, ...229
- Percussion Tone, ...133, 135
- Peschard, Dr. Albert 236
- Pilcher & Sons, Henry, Windchests, Combination Action 279, 283
- Pipes—Galvanized Sheet Iron, ... 28
- Pipes of Pan, ... 11
- Pitch—Standard 109
- Pipe Valve Pneumatics 260
- Pitman Stop Action, Operation of, ...207, 270, 273, 275
- Pneumatic Starter and Stopper, ... 63
- Pneumatic Lever, ... 15
  - (See Barker Lever)
- Positive 14
- Primary or Auxiliary Box 263, 274
  - Casavant, ... 288
- Prime Tones, ... 90
- Purchasing Organs, ...323
- Purist 72

- Qualities of Tone, How Produced, ... 41
- Quintaton, ... 54

- Recording of Automatic Records, ...314
- Reed or Shallot or Eshallot, ...58, 61, 74
- Reeds, Harmonic 68
- Reed Pipe Making, ...56, 68
- Reed Voicing, ...65
- Reedless Clarinet, ... 73
- Reedless Oboe, ... 73
- Regal, ... 14
- Register Crescendo, ...225
- Relay Action, ...244, 299
  - Hillgreen, Lane & Co. 321
  - Kilgen, ...321
  - Kimball, W. W. 302, 322
  - Moller, M. P. 324
- Renatus, ... 46
- Reservoir, High Pressure 22, 26
  - R. for Feeder 18, 22
- Resistance of Magnets, ...245
- Reuter Organ Co. 334
- Reversible Actions, ...325
- Richards Emerson, L. 8, 93, 112, 152
- Ripieno Mixtures, ... 87
- Riverbank Acoustical Laboratories ...112

PAGE

- Rochester Organ Company 53, 334
- Rollers, ...55, 99
- Roosevelt, Hilborne L...112, 226, 236, 331
  - Windchest, ...226, 259
  - Pneumatics, ...260, 261
- Rotary Blower, ... 18
  - Orgoblo, ... 25
  - Kinetic, ... 27
- Royal York Hotel Organ, ...163
- St. George's Hall, Liverpool,...48, 74, 229
- St. Gervais, Paris, ...110
- Salicionals, ...39, 52
- Salome, by Richard Strauss, ... 72
- Salter, Sumner, ... 72
- Saxophones, ... 73
- Scales of Organ Pipes, ...81-84
  - Hybrid & Special 83
- Schantz, A. J. & Sons 334
- Schulze, Edmund, German builder of England, Armley & Tyne Dock 16
  - S—Diapason, J. H. Schulze & Sons, ...46, 48, 50, 150
- Schwab, Harold 126
- Seam, in pipe 32
- Second or Double Touch, ...234
- Sesquicentennial Exposition Organ ...199
- Sforzando Pedal 325
- Shaefer, Chet "Grand Diapason" of Club 19
- Shallot, Eshallot
  - Open 58
  - Closed 58, 59, 61, 74
- Shutter Action,
  - Individual, Moller, ...116
  - Whiffle-tree, ...117
  - Kimball, ...118
- Shutters (Expression) 113
  - Austin, ...114, 120
  - Vacuum, ...114
  - Sound Trap, ...115
- Silbermann, Family of 15
- Silver Wire Contacts, ...143
- Skinner, Ernest M. ..54, 55, 63, 71, 72, 107, 111, 112, 143, 145, 191
  - "The Modern Organ"
- Skinner Organ Company, ...10, 63, 72, 93, 123, 143, 151, 192, 272
- Slider, defined 210
- Slotted, ... 32
- Smith, Father (English Builder)....16, 46
- Snetzler, John, German Builder in England, ...16, 46
- Soldering, Joints, necessity for 247
- Solo Reeds, ... 61
- Solo Stops, ...141
- Sommer, ... 15
- Sound Production in Organ Pipes, ... 37
- Space Requirements 196-201
- Spitz Flute, ...36, 52
- "Spotted" Metal 31
- Stainer, Sir John 13, 216

Page

- Stanley, George H. 158
- Stimme 140
- Steamboat Whistle 136
- Sticker, defined, ... 212
- Stop or Register, defined 208
- Stop Control, Keys, Tongues and Knobs 226
- Stoppers, ... 107
- Stopped Flute 54
- Strings — Echo Viol, Echo Gamba, Aeoline, Viole Sordine or Muted Viol 56
- String Tone 31, 44, 55, 96
- Sub Bass, ... 73
- Swell Organ Keyboard, defined 208
- Swell Pedal, Balanced, ... 111
  - Hitchdown, ... 111
  - Austin, ... 122
  - Moller, ... 122
  - Position of, ... 124

- Talmud, ... 13
- Tambourine, ... 136
- Tanneberger, David 94
- Tapped Wire, ... 212
- Tellers-Kent Organ Co. 334
- Tertullian, ... 13
- Thynne, William (Voicer) 55
- Tibias, ... 99
- Timbre, defined 95
  - Affected by voicing, ... 96
- Tip of Reed Tubes, ... 65
- Tonal Design, ... 139
  - of Church and Concert Organs, 146, 171
  - of Residence Organs, ... 174
  - of Theatre Organs, ... 179
  - Laws of, ... 150
- Tongue of Pipe, ... 57, 61
- Topboard, Pitman windchests, ... 278
- Touch, weight of 212
- Tracker, defined 211, 212
- Tracker Action described, ... 219
  - Console, ... 220
- Tracker Bar, ... 317
- Tracking Device, ... 317
- Transference of Stops, ... 186
- Transmission of Current, ... 242
- Traps, ... 137
- Tremont Temple, Boston, ... 92
- Tremulant, ... 56, 126, 130, 131
- Triangle, ... 136
- Trinity Lutheran Church, Lancaster.. 94
- Trombas, ... 65, 67
- Trumpet, (French) 62, 73
- Trumpet, ... 65
- Tuba Sonora, ... 63
- Tubas, ... 65, 67
- Tuba Mirabilis, ... 73
- Tubular Pneumatic Console, ... 223
- Tubular Pneumatic Action described, 215, 216
  - Stop Action, ... 217

Page

- Twenty-second, ... 52
- Tuning, ... 104
  - Equal Temperament, ... 104
  - Laying the Bearings, ... 105
- Tuning, Setting the Temperament 105
  - Effect of Temperature on 108
- Tuning Cones or Horns, ... 105
- Tuning Slide, ... 45
- Tuning Wires, ... 57, 61

- Unification, ... 186-193
- Unit Partials or Overtones, ... 193
- United States Organ Co. 334
- Upper Partials or Overtones, ... 90

- Valve Seat, ... 240
- Venetian Blind Swell, ... 111
- Ventil Stop Action, described, ... 260
- Viola Diapason or Geigen Principal,.. 52
- Viole d'Orchestre, ... 55
- Vitruvius, ... 12
- Voicing of Organ Pipes, ... 95
  - of Flue Pipes, ... 97
  - of Reed Pipes, ... 97
  - of Wood Pipes, ... 99
- Voicer, defined 95
- Voix Celeste, ... 128
- Votteler-Holtkamp-Sparling Co. 334
- Vox Humana, ... 67, 133

- Walcker, (German Builder) 111
- Wanamaker Store, Philadelphia 76, 140, 183
- Wangerin Organ Company 265, 334
- Water Motors, ... 19, 20
- Wave beats or Interference, ... 104
- Wedgwood, James, ... 59, 89, 126, 143 "Dictionary of Organ Stops"
- Weigle, Karl G. 236
- Welte-Tripp Organ Co. 76, 79, 204, 334
- Welte-Mignon Co. 308, 311
- Wentz, D. S. 178
- Wicks, Mark "Organ Building for Amateurs", ... 67
- Wicks, Direct Electric Action, ... 287, 291
  - Wicks Organ Company
- Willis, "Father" 16, 48, 72, 74
- Willis & Sons, Henry 217
- Willis, Henry 58, 59, 61, 63, 103, 143, 150, 174, 178
- Willis, Vincent, ... 74, 75
- Whiting, for pipes 37
- Williams College, ... 72
- Windchests,
  - Pallet & Slider, ... 208-210
  - Direct Electric, ... 287
  - Ventil Stop Action, ... 260
  - Pitman Stop Action, ... 270
  - Universal, ... 250
  - Hillgreen, Lane & Co. 284
- Wind Gauge, ... 23
- Wind Pressure, Measuring of 23
- Wurlitzer Co., The Rudolph 71, 116, 143, 334

- Xylophone 137

DATE DUE

JUL 1 '75			
FEB 4 '76			
DEC 6 '78			
DEC 19 '78			
~~FE 17 '88~~			
GAYLORD			PRINTED IN U.S.A.

ML
561
.B2

52260

Barnes, William Harrison

Contemporary American Organ

P. H. WELSHIMER MEMORIAL LIBRARY
MILLIGAN COLLEGE, TENN. 37682

T2-BXS-223